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THE ELECTRIC LIGHT.[1]

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THE subject of this evening's discourse was proposed by our late honorary secretary.[2] That word "late" has for me its own connotations. It implies, among other things, the loss of a comrade by whose side I have worked for thirteen years. On the other hand, regret is not without its opposite in the feeling with which I have seen him rise by sheer intrinsic merit, moral and intellectual, to the highest official position which it is in the power of English science to bestow. Well, he, whose constant desire and practice were to promote the interests and extend the usefulness of this institution, thought that, at a time when the electric light occupied so much of public attention, a few sound notions regarding it, on the more purely scientific side, might, to use his own pithy expression, be "planted" in the public mind. I am here to-night with the view of trying, to the best of my ability, to realize the idea of our friend.

In the year 1800 Volta announced his immortal discovery of the pile. Whetted to eagerness by the previous conflict between him and Galvani, the scientific men of the age flung themselves with ardor upon the new discovery, repeating Volta's experiments, and extending them in many ways. The light and heat of the voltaic circuit attracted marked attention, and in the innumerable tests and trials to which this question was subjected, the utility of platinum and charcoal as means of exalting the light was on all hands recognized. Mr. Children, with a battery surpassing in strength all its predecessors, fused platinum wires eighteen inches long, while "points of charcoal produced a light

[1] A discourse delivered at the Royal Institution of Great Britain on Friday, January 17, 1879.

[2] Mr. William Spottiswoode, now President of the Royal Society.

so vivid that the sunshine, compared with it, appeared feeble."[1] Such effects reached their culmination when, in 1808, through the liberality of a few members of the Royal Institution, Davy was enabled to construct a battery of two thousand pairs of plates, with which he afterward obtained calorific and luminous effects far transcending anything previously observed. The arc of flame between the carbon terminals was four inches long, and by its heat quartz, sapphire, magnesia, and lime were melted like wax in a candle-flame; while fragments of diamond and plumbago rapidly disappeared, as if reduced to vapor.[2]

The first condition to be fulfilled in the development of heat and light by the electric current is that it shall encounter and overcome resistance. Flowing through a perfect conductor, no matter what the strength of the current might be, neither heat nor light could be developed. A rod of unresisting copper carries away uninjured and unwarmed an atmospheric discharge competent to shiver to splinters a resisting oak. I send the self-same current through a wire composed of alternate lengths of silver and platinum. The silver offers little resistance, the platinum offers much. The consequence is that the platinum is raised to a white heat, while the silver is not visibly warmed. The same holds good with regard to the carbon terminals employed for the production of the electric light. The interval between them offers a powerful resistance to the passage of the current, and it is by the gathering up of the force necessary to burst across this interval that the voltaic current is able to throw the carbon into that state of violent intestine commotion which we call heat, and to which its effulgence is due. The smallest interval of air usually suffices to stop the current. But when the carbon points are first brought together and then separated, there occurs between them a discharge of incandescent matter which carries, or may carry, the current over a considerable space. The light comes almost wholly from the incandescent carbons. The space between them is filled with a blue flame which, being usually bent by the earth's magnetism, receives the name of the Voltaic Arc.

For seventy years, then, we have been in possession of this transcendent light without applying it to the illumination of our streets and houses. Such applications suggested themselves at the outset, but there were grave difficulties in their way. The first difficulty arose from the waste of the carbons, which are dissipated in part by ordinary combustion, and in part by the electric transfer of matter from the one carbon to the other. To keep the carbons at the proper distance asunder, regulators were devised—the earliest, I believe, by Staite, and

[1] Davy, "Chemical Philosophy," p. 110.

[2] In the concluding lecture at the Royal Institution in June, 1810, Davy showed the action of this battery. He then fused iridium, the alloy of iridium and osmium, and other refractory substances. See "Philosophical Magazine," vol. xxxv., p. 463. Quetelet assigns the first production of the spark between coal-points to Curtet in 1802. Davy certainly in that year showed the carbon-light with a battery of 150 pairs of plates in the theatre of the Royal Institution ("Journal of the Royal Institution," vol. i., p. 166).

the most successful by Duboscq, Foucault, and Serrin, who have been succeeded by Holmes, Siemens, Browning, Carré, Gramme, Lontin, and others. By such arrangements the first difficulty was practically overcome; but the second, a graver one, is probably inseparable from the construction of the voltaic battery. It arises from the operation of that inexorable law which, throughout the material universe, demands an eye for an eye and a tooth for a tooth, refusing to yield the faintest glow of heat or glimmer of light without the expenditure of an absolutely equal quantity of some other power. Hence, in practice, the desirability of any transformation must depend upon the value of the product in relation to that of the power expended. The metal zinc can be burned like paper; it might be ignited in a flame, but it is possible to avoid the introduction of all foreign heat and to burn the zinc in air of the temperature of this room. This is done by placing zinc-foil at the focus of a concave mirror, which concentrates to a point the divergent electric beam, but which does not warm the air. The zinc burns at the focus with a violet flame, and we could readily determine the amount of heat generated by its combustion. But zinc can be burned not only in air but in liquids. It is thus burned when acidulated water is poured over it; it is also thus burned in the voltaic battery. Here, however, to obtain the oxygen necessary for its combustion, the zinc has to dislodge the hydrogen with which the oxygen is combined. The consequence is, that the heat due to the combustion of the metal in the liquid falls short of that developed by its combustion in air, by the exact quantity necessary to separate the oxygen from the hydrogen. Fully four fifths of the total heat is used up in this molecular work, only one fifth remaining to warm the battery. It is upon this residue that we must now fix our attention, for it is solely out of it that we manufacture our electric light.

Before you are two small voltaic batteries of ten cells each. The two ends of one of them are united by a thick copper wire, while into the circuit of the other a thin platinum wire is introduced. The platinum glows with a white heat, while the copper wire is not sensibly warmed. Now an ounce of zinc, like an ounce of coal, produces by its complete combustion in air a constant quantity of heat. The total heat developed by an ounce of zinc through its union with oxygen in the battery is also absolutely invariable. Let our two batteries, then, continue in action until an ounce of zinc in each of them is consumed. In the one case the heat generated is purely domestic, being liberated on the hearth where the fuel is burned, that is to say in the cells of the battery itself. In the other case, the heat is in part domestic and in part foreign—in part within the battery and in part outside. One of the fundamental truths to be borne in mind is that the sum of the foreign and domestic—of the external and internal—heats is fixed and invariable. Hence, to have heat outside you must draw upon the heat within. These remarks apply to the electric light. By the intermediation of the

electric current the moderate warmth of the battery is not only carried away but concentrated, so as to produce, at any distance from its origin, a heat next in order to that of the sun. The current might therefore be defined as the swift carrier of heat. Loading itself here with invisible power, by a process of transmutation which outstrips the dreams of the alchemist, it can discharge its load, in the fraction of a second, as light and heat, at the opposite side of the world.

Thus, the light and heat produced outside the battery are derived from the metallic fuel burned within the battery; and, as zinc happens to be an expensive fuel, though we have possessed the electric light for more than seventy years, it has been too costly to come into general use. But within these walls, in the autumn of 1831, Faraday discovered a new source of electricity, which we have now to investigate. On the table before me lies a coil of covered copper wire, with its ends disunited. I lift one side of the coil from the table, and in doing so exert the muscular effort necessary to overcome the simple weight of the coil. I unite its two ends and repeat the experiment. The effort now required, if accurately measured, would be found greater than before. In lifting the coil I cut the lines of the earth's magnetic force, such cutting, as proved by Faraday, being always accompanied, in a closed conductor, by the production of an "induced" electric current which, as long as the ends of the coil remained separate, had no circuit through which it could pass. The current here evoked subsides immediately as heat; this heat being the exact equivalent of the excess of effort just referred to as over and above that necessary to overcome the simple weight of the coil. When the coil is liberated it falls back to the table, and when its ends are united it encounters a resistance over and above that of the air. It generates an electric current opposed in direction to the first, and reaches the table with a diminished shock. The amount of the diminution is accurately represented by the warmth which the momentary current develops in the coil. Various devices were employed to exalt these induced currents, among which the instruments of Pixii, Clarke, and Saxton were long conspicuous. Faraday, indeed, foresaw that such attempts were sure to be made; but he chose to leave them in the hands of the mechanician, while he himself pursued the deeper study of facts and principles. "I have rather," he writes in 1831, "been desirous of discovering new facts and new relations dependent on magneto-electric induction than of exalting the force of those already obtained; being assured that the latter would find their full development hereafter."

For more than twenty years magneto-electricity had subserved its first and noblest purpose of augmenting our knowledge of the powers of nature. It had been discovered and applied to intellectual ends, its application to practical ends being still unrealized. The Drummond light had raised thoughts and hopes of vast improvements in public illumination. Many inventors tried to obtain it cheaply; and in

1853 an attempt was made to organize a company in Paris for the purpose of procuring, through the decomposition of water by a powerful magneto-electric machine constructed by M. Nollet, the oxygen and hydrogen necessary for the lime-light. The experiment failed, but the apparatus by which it was attempted suggested to Mr. Holmes other and more hopeful applications. Abandoning the attempt to produce the lime-light, with persevering skill Holmes continued to improve the apparatus and to augment its power, until it was finally able to yield a magneto-electric light comparable to that of the voltaic battery. Judged by later knowledge, this first machine would be considered cumbrous and defective in the extreme ; but, judged by the light of antecedent events, it marked a great step forward.

Faraday was profoundly interested in the growth of his own discovery. The Elder Brethren of the Trinity House had had the wisdom to make him their "Scientific Adviser"; and it is interesting to notice, in his reports regarding the light, the mixture of enthusiasm and caution which characterized him. Enthusiasm was with him a motive power, guided and controlled by a disciplined judgment. He rode it as a charger, holding it in by a strong rein. While dealing with Holmes, he states the case of the light *pro* and *con*. He checks the ardor of the inventor, and, as regards cost, rejecting sanguine estimates, he insists over and over again on the necessity of continued experiment for the solution of this important question. His matured opinion was, however, strongly in favor of the light. "I beg to state," he writes in his report to the Elder Brethren, "that, in my opinion, Professor Holmes has practically established the fitness and sufficiency of the magneto-electric light for lighthouse purposes, so far as its nature and management are concerned. The light produced is powerful beyond any other that I have yet seen so applied, and in principle may be accumulated to any degree ; its regularity in the lantern is great ; its management easy, and its care there may be confided to attentive keepers of the ordinary degree of intellect and knowledge." As regards the conduct of Professor Holmes during these memorable experiments, it is only fair to add the following remark with which Faraday closes the report submitted to the Elder Brethren of the Trinity House on the 29th of April, 1859: "I must bear my testimony," he says, "to the perfect openness, candor, and honor of Professor Holmes. He has answered every question, concealed no weak point, explained every applied principle, given every reason for a change either in this or that direction, during several periods of close questioning, in a manner that was very agreeable to me, whose duty it was to search for real faults or possible objections in respect both of the present time and the future."[1]

Soon afterward the Elder Brethren of the Trinity House had the intelligent courage to establish the machines of Holmes permanently at

[1] Holmes's first offer of his machine to the Trinity House bears the date February 2, 1857.

Dungeness, where the magneto-electric light continued to shine for many years.

The magneto-electric machine of the Alliance Company soon succeeded that of Holmes, and was in various ways a very marked improvement on the latter. Its currents were stronger and its light brighter than those of its predecessor. In it, moreover, the commutator, the flashing and destruction of which were sources of irrregularity and deterioration in the machine of Holmes, was, at the suggestion of M. Masson,[1] entirely abandoned; alternating currents instead of the direct current being employed. M. Serrin modified his excellent lamp with the express view of enabling it to cope with alternating currents. During the International Exhibition of 1862, where the machine was shown, M. Berlioz offered to dispose of the invention to the Elder Brethren of the Trinity House. They referred the matter to Faraday, and he replied as follows: "I am not aware that the Trinity House authorities have advanced so far as to be able to decide whether they will require more magneto-electric machines, or whether, if they should require them, they see reason to suppose the means of their supply in this country, from the source already open to them, would not be sufficient. Therefore I do not see that at present they want to purchase a machine." Faraday was obviously swayed by the desire to protect the interests of Holmes, who had borne the burden and heat which fall upon the pioneer. The Alliance machines were introduced with success at Cape La Hève, near Havre; and the Elder Brethren of the Trinity House, determined to have the best available apparatus, decided, in 1868, on the introduction of machines on the Alliance principle into the lighthouses at Souter Point and the South Foreland. These machines were constructed by Professor Holmes, and they still continue in operation. With regard, then, to the application of electricity to lighthouse purposes, the course of events was this: The Dungeness light was introduced on January 31, 1862; the light at La Hève on December 26, 1863, or nearly two years later. But Faraday's experimental trial at the South Foreland preceded the lighting of Dungeness by more than two years. The electric light was afterward established at Cape Grinez. The light was started at Souter Point on January 11, 1871; and at the South Foreland on January 1, 1872. At the Lizard, which probably enjoys the newest and most powerful development of the electric light, it began to shine on January 1, 1878.

I have now to revert to a point of apparently small moment, but which really constitutes an important step in the development of this subject. I refer to the form given in 1857 to the rotating armature by Dr. Werner Siemens, of Berlin. Instead of employing coils wound transversely round cores of iron, as in the machine of Saxton, Siemens, after giving a bar of iron the proper shape, wound his wire longitudinally

[1] Du Moncel, "L'Électricité," August, 1878, p. 150.

round it, and obtained thereby greatly augmented effects between suitably placed magnetic poles. Such an armature is employed in the small magneto-electric machine which I now introduce to your notice, and for which the institution is indebted to Mr. Henry Wilde, of Manchester. There are here sixteen permanent horseshoe magnets placed parallel to each other, and between their poles a Siemens armature. The two ends of the wire which surrounds the armature are now disconnected. In turning the handle and causing the armature to rotate, I simply overcome ordinary mechanical friction. But the two ends of the armature coil can be united in a moment, and when this is done I immediately experience a greatly increased resistance to rotation. Something over and above the ordinary friction of the machine is now to be overcome, and by the expenditure of an additional amount of muscular force I am able to overcome it. The excess of labor thus thrown upon my arm has its exact equivalent in the electric currents generated, and the heat produced by their subsidence in the coil of the armature. A portion of this heat may be rendered visible by connecting the two ends of the coil with a thin platinum wire. When the handle of the machine is rapidly turned the wire glows, first with a red heat, then with a white heat, and finally with the heat of fusion. The moment the wire melts the circuit round the armature is broken, an instant relief from the labor thrown upon the arm being the consequence. Clearly realize the equivalent of the heat here developed. During the period of turning the machine a certain amount of combustible substance was oxidized or burned in the muscles of my arm. Had it done no external work the matter consumed would have produced a definite amount of heat. Now, the muscular heat actually developed during the rotation of the machine fell short of this definite amount, the missing heat being reproduced to the last fraction in the glowing platinum wire and the other parts of the machine. Here, then, the electric current intervenes between my muscles and the generated heat, exactly as it did a moment ago between the voltaic battery and its generated heat. The electric current is to all intents and purposes a vehicle which transports the heat both of muscle and battery to any distance from the hearth where the fuel is consumed. Not only is the current a messenger, but it is also an intensifier of magical power. The temperature of my arm is, in round numbers, 100° Fahr., and it is by the intensification of this heat that one of the most refractory of metals, which requires a heat of 3,600° Fahr. to fuse it, has been reduced to the molten condition.

Zinc, as I have said, is a fuel far too expensive to permit of the electric light produced by its combustion being used for the common purposes of life, and you will readily perceive that the human muscles, or even the muscles of a horse, would be more expensive still. Here, however, we can employ the force of burning coal to turn our machine, and it is this employment of our cheapest fuel, rendered possible by

Faraday's discovery, which opens out the prospect of our being able to apply the electric light to public use.

In 1866 a great step in the intensification of induced currents, and the consequent augmentation of the magneto-electric light, was taken by Mr. Henry Wilde. It fell to my lot to report upon them to the Royal Society, but before doing so I took the trouble of going to Manchester to witness Mr. Wilde's experiments. He operated in this way: Starting from a small machine like that worked in your presence a moment ago, he employed its current to excite an electro-magnet of a peculiar shape, between whose poles rotated a Siemens armature;[1] from this armature currents were obtained vastly stronger than those generated by the small magneto-electric machine. These currents might have been immediately employed to produce the electric light; but instead of this they were conducted round a second electro-magnet of vast size, between whose poles rotated a Siemens armature of corresponding dimensions. Three armatures therefore were involved in this series of operations: 1. The armature of the small magneto-electric machine; 2. The armature of the first electro-magnet, which was of considerable size; and, 3. The armature of the second electro-magnet, which was of vast dimensions. With the currents drawn from this third armature, Mr. Wilde obtained effects, both as regards heat and light, enormously transcending those previously known.[2]

But the discovery which, above all others, brought the practical question to the front is now to be considered. On the 4th of February, 1867, a paper was received by the Royal Society from Mr. William Siemens, bearing the title, "On the Conversion of Dynamic into Electrical Force without the Use of Permanent Magnetism."[3] On the 14th of February a paper from Sir Charles Wheatstone was received, bearing the title, "On the Augmentation of the Power of a Magnet by the

[1] Page and Moigno had previously shown that the magneto-electric current could produce powerful electro-magnets.

[2] Mr. Wilde's paper is published in the "Philosophical Transactions" for 1867, p. 89. My opinion regarding Wilde's machine was briefly expressed in a report to the Elder Brethren of the Trinity House on the 17th of May, 1866: "It gives me pleasure to state that the machine is exceedingly effective, and that it far transcends in power all other apparatus of the kind."

[3] A paper on the same subject, by Dr. Werner Siemens, was read on the 17th of January, 1867, before the Academy of Sciences in Berlin. In a letter to "Engineering," No. 622, p. 45, Mr. Robert Sabine states that Professor Wheatstone's machines were constructed by Mr. Stroh in the months of July and August, 1866. I do not doubt Mr. Sabine's statement; still it would be dangerous in the highest degree to depart from the canon, in asserting which Faraday was specially strenuous, that the date of a discovery is the date of its publication. Toward the end of December, 1866, Mr. Alfred Varley also lodged a provisional specification (which, I believe, is a sealed document) embodying the principles of the dynamo-electric machine, but some years elapsed before he made anything public. His brother, Mr. Cromwell Varley, when writing on this subject in 1867, does not mention him ("Proceedings of the Royal Society," March 14, 1867). It probably marks a national trait that sealed communications, though allowed in France, have never been recognized by the scientific societies of England.

Reaction thereon of Currents induced by the Magnet itself." Both papers, which dealt with the same discovery, and which were illustrated by experiments, were read upon the same night, viz., the 14th of February. The whole field of science hardly furnishes a more beautiful example of the interaction of natural forces than that set forth in these two papers. You can hardly find a bit of iron—you can hardly pick up an old horseshoe, for example—that does not possess a trace of permanent magnetism; and from such a small beginning Siemens and Wheatstone have taught us to rise by a series of interactions between magnet and armature to a magnetic intensity previously unapproached. Conceive the Siemens armature placed between the poles of a suitable electro-magnet. Suppose this latter to possess at starting the faintest trace of magnetism; when the armature rotates, currents of infinitesimal strength are generated in its coil. Let the ends of that coil be connected with the wire surrounding the electro-magnet. The infinitesimal current generated in the armature will then circulate round the magnet, augmenting its intensity by an infinitesimal amount. The strengthened magnet instantly reacts upon the coil which feeds it, producing a current of greater strength. This current again passes round the magnet, which immediately brings its enhanced power to bear upon the coil. By this play of mutual give and take between magnet and armature, the strength of the former is raised in a very brief interval from almost nothing to complete magnetic saturation. Such a magnet and armature are able to produce currents of extraordinary power, and if an electric lamp be introduced into the common circuit of magnet and armature, we can readily obtain a most powerful light.[1] By this discovery, then, we are enabled to avoid the trouble and expense involved in the employment of permanent magnets; we are also enabled to drop the exciting magneto-electric machine, and the duplication of the electro-magnets. By it, in short, the electric generator is so far simplified, and reduced in cost, as to enable electricity to enter the lists as the rival of our present means of illumination.

Soon after the announcement of their discovery by Siemens and Wheatstone, Mr. Holmes, at the instance of the Elder Brethren of the Trinity House, endeavored to turn this discovery to account for light-house purposes. Already, in the spring of 1869, he had constructed a machine which, though hampered with defects, exhibited extraordinary power. The light was developed in the focus of a dioptric apparatus placed on the Trinity Wharf at Blackwall, and witnessed by the Elder Brethren, Mr. Douglass, and myself, from an observatory at Charlton, on the opposite side of the Thames. Falling upon the suspended haze, the light illuminated the atmosphere for miles all round. Anything so sunlike in splendor had not, I imagine, been previously witnessed. The

[1] In 1867 Mr. Ladd introduced the modification of dividing the armature into two separate coils, one of which fed the electro-magnets, while the other yielded the induced currents.

apparatus of Holmes, however, was rapidly distanced by the safer and more powerful machines of Siemens and Gramme.

As regards lighthouse illumination, the next step forward was taken by the Elder Brethren of the Trinity House in 1876–'77. Having previously decided on the establishment of the electric light at the Lizard in Cornwall, they instituted at the time referred to an elaborate series of comparative experiments wherein the machinery of Holmes, of the Alliance Company, of Siemens, and of Gramme, were pitted against each other. The Siemens and the Gramme machines delivered direct currents, while those of Holmes and the Alliance Company delivered alternating currents. The light of the latter was of the same intensity in all azimuths round the place of observation; that of the former was different in different azimuths, the discharge being so regulated as to yield a gush of light of special intensity in one direction. The following table gives in standard candles the performance of the respective machines:[1]

Name of Machines.	Maximum.	Minimum.
Holmes	1,523	1,523
Alliance	1,953	1,953
Gramme (No. 1)	6,663	4,016
" (No. 2)	6,663	4,016
Siemens (large)	14,818	8,932
" (small, No. 1)	5,359	3,339
" (small, No. 2)	6,864	4,138
Two Holmes's coupled	2,811	2,811
Two Gramme's	11,396	6,869
Two Siemens's (Nos. 1 and 2)	14,134	8,520

These determinations were made by Mr. Douglass, the engineer-in-chief, and Mr. Ayres, the assistant engineer of the Trinity House. After this contest, which was conducted throughout in the most amicable manner, Siemens machines of the smaller type were chosen for the Lizard.[2]

We have machines capable of sustaining a single light and also machines capable of sustaining several lights. The Gramme machine, for example, which ignites the Jablochkoff candles on the Thames Embankment and at the Holborn Viaduct, delivers four currents, each passing through its own circuit. In each circuit are five lamps through which the current belonging to the circuit passes in succession. The lights correspond to so many resisting spaces, over which, as already explained, the current has to leap; the force which accomplishes the

[1] Observations from the sea on the night of November 21, 1876, made the Gramme and small Siemens practically equal to the Alliance. But the photometric observations, in which the external resistance was abolished, and previous to which the light-keepers had become more skilled in the management of the direct current, showed the differences recorded in the table. A close inspection of these powerful lights at the South Foreland caused my face to peel, as if it had been irritated by an Alpine sun.

[2] As the result of a recent trial by Mr. Schwendler, they have been also chosen for India.

leap being that which produces the light. Whether the current is to be competent to pass through five lamps in succession, or to sustain only a single lamp, depends entirely upon the will and skill of the maker of the machine. He has, to guide him, definite laws laid down by Ohm half a century ago, by which he must abide.

Ohm has taught us how to arrange the elements of our battery so as to augment indefinitely its electro-motive force—that force, namely, which urges the current forward and enables it to surmount external obstacles. We have only to link the cells together so that the current generated by each cell shall pass through all the others, and add its electro-motive force to that of all the others. We increase, it is true, at the same time the resistance of the battery, diminishing thereby the quantity of the current from each cell, but we augment the power of the integrated current to overcome external hindrances. The resistance of the battery itself may, indeed, be rendered so great that the external resistance shall vanish in comparison. What is here said regarding the voltaic battery is equally true of magneto-electric machines. If we wish our current to leap over five intervals, and produce five lights in succession, we must invoke a sufficient electro-motive force. This is done through multiplying by the use of thin wires the convolutions of the rotating armature as, a moment ago, we augmented the cells of our voltaic battery. Each additional convolution, like each additional cell, adds its electro-motive force to that of all the others; and, though it also adds its resistance, thereby diminishing the quantity of current contributed by each convolution, the integrated current becomes endowed with the power of leaping across the successive spaces necessary for the production of a series of lights in its course. The current is, as it were, rendered at once thinner and more piercing by the simultaneous addition of internal resistance and electro-motive power. The machines, on the other hand, which produce only a single light have a small internal resistance associated with a small electro-motive force. In such machines the wire of the rotating armature is comparatively short and thick, copper ribbon instead of wire being commonly employed. Such machines deliver a large quantity of electricity of low tension—in other words, of low leaping power. Hence, though competent when their power is converged upon a single interval to produce one splendid light, their currents are unable to force a passage when the number of intervals is increased. Thus, by augmenting the convolutions of our machines, we sacrifice quantity and gain electro-motive force; while, by lessening the number of the convolutions, we sacrifice electro-motive force and gain quantity. Whether we ought to choose the one form of machine or the other depends entirely upon the external work the machine has to perform. If the object be to obtain a single light of great splendor, machines of low resistance and large quantity must be employed. If we want to obtain in the same circuit several lights of moderate intensity, machines of high internal

resistance and of correspondingly high electro-motive power must be invoked.

When a coil of covered wire surrounds a bar of iron, the two ends of the coil being connected together, every alteration of the magnetism of the bar is accompanied by the development of an induced current in the coil. The current is only excited during the period of magnetic change. No matter how strong or how weak the magnetism of the bar may be, as long as its condition remains permanent no current is developed. Conceive, then, the pole of a magnet placed near one end of the bar to be moved along it toward the other end. During the time of the pole's motion there will be an incessant change in the magnetism of the bar, and accompanying this change we shall have an induced current in the surrounding coil. If, instead of moving the magnet, we move the bar and its surrounding coil past the magnetic pole, a similar alteration of the magnetism of the bar will occur, and a similar current will be induced in the coil. You have here the fundamental conception which led M. Gramme to the construction of his beautiful machine.[1] He aimed at giving continuous motion to such a bar as we have here described ; and for this purpose he bent it into a continuous ring, which, by a suitable mechanism, he caused to rotate rapidly close to the poles of a horseshoe magnet. The direction of the current varied with the motion and with the character of the influencing pole. The result was that the currents in the two semicircles of the coil surrounding the ring flowed in opposite directionss. But it was easy, by the mechanical arrangement called a commutator, to gather up the currents and cause them to flow in the same direction. The first machines of Gramme, therefore, furnished *direct* currents, similar to those yielded by the voltaic pile. M. Gramme subsequently so modified his machine as to produce alternating currents. Such machines are employed to produce the lights now exhibited on the Holborn Viaduct and the Thames Embankment.

Another machine of great alleged merit is that of M. Lontin. It resembles in shape a toothed iron wheel, the teeth being used as cores, round which are wound coils of copper wire. The wheel is caused to rotate between the opposite poles of powerful electro-magnets. On passing each pole the core or tooth is strongly magnetized, and instantly evokes in the surrounding coil an induced current of corresponding strength. The currents excited in approaching and retreating, and in passing different poles, move in opposite directions, but by means of a commutator these conflicting electric streams are gathered up and caused to flow in a common bed. The bobbins in which the currents are induced can be so increased in number as to augment indefinitely the power of the machine. To excite his electro-magnets, M. Lontin applies the principle of Mr. Wilde. A small machine furnishes a direct

[1] "Comptes Rendus," 1871, p. 176. See also Gaugain on the Gramme machine, "Ann. de Chim. et de Phys.," vol. xxviii., p. 324.

current, which is carried round the electro-magnets of a second and larger machine. Wilde's principle, it may be added, is also applied on the Thames Embankment and the Holborn Viaduct; a small Gramme machine being used in each case to excite the electro-magnets of the large ones.

The Farmer-Wallace machine is also an apparatus of great power. It consists of a combination of bobbins for induced currents, and of inducing electro-magnets, the latter being excited by the method discovered by Siemens and Wheatstone. In the machines intended for the production of the electric light, the electro-motive force is so great as to permit of the introduction of several lights in the same circuit. A peculiarly novel feature of the Farmer-Wallace system is the shape of the carbons. Instead of rods two large plates of carbons with beveled edges are employed, one above the other. The electric discharge passes from edge to edge, and shifts its position according as the carbon is dissipated. The duration of the light in this case far exceeds that obtainable with rods. I have myself seen four of these lights in the same circuit in Mr. Ladd's workshop in the city, and they are now, I believe, employed at the Liverpool Street Station of the Metropolitan Railway. The Farmer-Wallace "quantity machine" pours forth a flood of electricity of low tension. It is unable to cross the interval necessary for the production of the electric light, but it can fuse thick copper wires. When sent through a short bar of iridium, this refractory metal emits a light of extraordinary splendor.[1]

The machine of M. de Méritens, which he has generously brought over from Paris for our instruction, is the newest of all. In its construction he falls back upon the principle of the magneto-electric machine, employing permanent magnets as the exciters of the induced currents. Using the magnets of the Alliance Company, by a skillful disposition of his bobbins, M. de Méritens produces with eight magnets a light equal to that produced by forty magnets in the Alliance machines. While the space occupied is only one fifth, the cost is little more than one fourth that of the latter. In the De Méritens machine the commutator is abolished. The internal heat is hardly sensible, and the absorption of power, in relation to the effects produced, is small. With his larger machines M. de Méritens maintains a considerable number of lights in the same circuit.[2]

In relation to this subject inventors fall into two classes, the contrivers of regulators and the constructors of machines. M. Rapieff has hitherto belonged to inventors of the first class, but I have reason to

[1] The iridium light was shown by Mr. Ladd. It brilliantly illuminated the theatre of the Royal Institution.

[2] The small machine transforms one and a quarter horse-power into heat and light, yielding about 1,900 candles; the large machine transforms five horse-power, yielding about 9,000 candles.

know that he is engaged on a machine which, when complete, will place him in the other class also. Instead of two single carbon rods, M. Rapieff employs two pairs of rods, each pair forming a V. The light is produced at the common junction of the four carbons. The device for regulating the light is of the simplest character. At the bottom of the stand which supports the carbons are two small electro-magnets. One of them, when the current passes, draws the carbons together, and in so doing throws itself out of circuit, leaving the control of the light to the other. The carbons are caused to approach each other by a descending weight, which acts in conjunction with the electro-magnet. Through the liberality of the proprietors of the "Times" every facility has been given to M. Rapieff to develop and simplify his invention at Printing House Square. The illumination of the press-room, which I had the pleasure of witnessing, under the guidance of M. Rapieff himself, is extremely effectual and agreeable to the eye. There are, I believe, five lamps in the same circuit, and the regulators are so devised that the extinction of any lamp does not compromise the action of the others. M. Rapieff has lately improved his regulator.

Many other inventors might here be named, and fresh ones are daily crowding in. Mr. Werdermann has been long known in connection with this subject. Employing as negative carbon a disk, and as positive carbon a rod, he has, I am assured, obtained very satisfactory results. The small resistances brought into play by his minute arcs enable Mr. Werdermann to introduce a number of lamps into a circuit traversed by a current of only moderate electro-motive power. M. Reynier is also the inventor of a very beautiful little lamp, in which the point of a thin carbon rod, properly adjusted, is caused to touch the circumference of a carbon wheel which rotates underneath the point. The light is developed at the place of contact of rod and wheel. One of the last steps, though I am informed not quite the last, in the improvement of regulators is this: The positive carbon wastes more profusely than the negative, and this is alleged to be due to the greater heat of the former. It occurred to Mr. William Siemens to chill the negative artificially, with the view of diminishing or wholly preventing its waste. This he accomplishes by making the negative pole a hollow cone of copper, and by ingeniously discharging a small jet of cold water against the interior of the cone. His negative of copper is thus caused to remain fixed in space, for it is not dissipated, the positive carbon only needing control. I have seen this lamp in action, and can bear witness to its success.

I might go on to other inventions, achieved or projected. Indeed, there is something bewildering in the recent rush of constructive talent into this domain of applied electricity. The question and its prospects are modified from day to day, a steady advance being made toward the improvement both of machines and regulators. With regard to our public lighting, I strongly lean to the opinion that the electric light

will at no distant day triumph over gas. I am not so sure that it will do so in our private houses. As, however, I am anxious to avoid dropping a word here that could influence the share market in the slightest degree, I limit myself to this general statement of opinion.

To one inventor in particular belongs the honor of the idea, and the realization of the idea, of causing the carbon rods to burn away like a candle. It is needless for me to say that I here refer to the young Russian officer, M. Jablochkoff. He sets two carbon rods upright at a small distance apart, and fills the space between them with an insulating substance like plaster of Paris. The carbon rods are fixed in metallic holders. A momentary contact is established between the two carbons by a little cross-piece of the same substance placed horizontally from top to top. This cross-piece is immediately dissipated or removed by the current, the passage of which once established is afterward maintained. The carbons gradually waste, while the substance between them melts like the wax of a candle. The comparison, however, only holds good for the act of melting; for, as regards the current, the insulating plaster is practically inert. Indeed, as proved by M. Rapieff and Mr. Wilde, the plaster may be dispensed with altogether, the current passing from point to point between the naked carbons. M. de Méritens has recently brought out a new candle, in which the plaster is abandoned, while between the two principal carbons is placed a third insulated rod of the same material. With the small De Méritens machine two of these candles can be lighted before you; they produce a very brilliant light.[1] In the Jablochkoff candle it is necessary that the carbons should be consumed at the same rate. Hence the necessity for alternating currents by which this equal consumption is secured. It will be seen that M. Jablochkoff has abolished regulators altogether, introducing the candle principle in their stead. In my judgment, the performance of the Jablochkoff candle on the Thames Embankment and the Holborn Viaduct is highly creditable, notwithstanding a considerable waste of light toward the sky. The Jablochkoff lamps, it may be added, would be more effective in a street, where their light would be scattered abroad by the adjacent houses, than in the positions which they now occupy in London.

It was my custom some years ago, whenever I needed a new and complicated instrument, to sit down beside its proposed constructor, and to talk the matter over with him. The study of the inventor's mind which this habit opened out was always of the highest interest to me. I particularly well remember the impression made upon me on such occasions by the late Mr. Darker, a philosophical instrument maker in Lambeth. This man's life was a struggle, and the reason of it was

[1] Both the machines of M. de Méritens and the Farmer-Wallace machine were worked by an excellent gas-engine, lent for the occasion by the Messrs. Crossley, of Manchester. The Siemens machine was worked by steam.

not far to seek. No matter how commercially lucrative the work upon which he was engaged might be, he would instantly turn aside from it to seize and realize the ideas of a scientific man. He had an inventor's power, and an inventor's delight in its exercise. The late Mr. Becker possessed the same power in a very considerable degree. On the Continent, Froment, Breguet, Sauerwald, and others might be mentioned as eminent instances of ability of this kind. Such minds resemble a liquid on the point of crystallization. Stirred by a hint, crystals of constructive thought immediately shoot through them. That Mr. Edison possesses this intuitive power in no common measure is proved by what he has already accomplished. He has the penetration to seize the relationship of facts and principles, and the art to reduce them to novel and concrete combinations. Hence, though he has thus far accomplished nothing that we can recognize as new in relation to the electric light, an adverse opinion as to his ability to solve the complicated problem on which he is engaged would be unwarranted.

I will endeavor to illustrate in a simple manner Mr. Edison's alleged mode of electric illumination, taking advantage of what Ohm has taught us regarding the laws of the current, and what Joule has taught us regarding the relation of resistance to the development of light and heat. From one end of a voltaic battery runs a wire, dividing at a certain point into two branches which reunite in a single wire connected with the other end of the battery. From the positive end of the battery the current passes first through the single wire to the point of junction, where it divides itself between the branches according to a well-known law. If the branches be equally resistant, the current divides itself equally between them. If one branch be less resistant than the other, more than half the current will choose the freer path. The strict law is that the quantity of current is inversely proportional to the resistance. A clear image of the process is derived from the deportment of water. When a river meets an island it divides, passing right and left of the obstacle, and afterward reuniting. If the two branch beds be equal in depth, width, and inclination, the water will divide itself equally between them. If they be unequal, the larger quantity of water will flow through the more open course. And as, in the case of the water, we may have an indefinite number of islands producing an indefinite subdivision of the trunk stream, so in the case of electricity we may have, instead of two branches, any number of branches, the current dividing itself among them, in accordance with the law which fixes the relation of flow to resistance.

Let us apply this knowledge. Suppose an insulated copper rod, which we may call an "electric main," to be laid down along one of our streets, say along the Strand. Let this rod be connected with one end of a powerful voltaic battery, a good metallic connection being established between the other end of the battery and the gas-pipes under the street. As long as the electric main continues unconnected

with the gas-pipes, the circuit is incomplete and no current will flow; but if any part of the main, however distant from the battery, be connected with the adjacent gas-pipes, the circuit will be completed and the current will flow. Supposing our battery to be at Charing Cross, and our rod of copper to be tapped opposite Somerset House, a branch wire can be carried from the rod into the building, the current passing through which may be subdivided into any number of subordinate branches which reunite afterward and return through the gas-pipes to the battery. The branch currents may be employed to raise to vivid incandescence a refractory metal like iridium or one of its alloys. Instead of being tapped at one point, our main may be tapped at one hundred points. The current will divide in strict accordance with law, its power to produce light being solely limited by its strength. The process of division closely resembles the circulation of the blood; the electric main carrying the outgoing current representing a great artery, the gas-pipes carrying the return current representing a great vein, while the intermediate branches represent the various vessels by which the blood is distributed through the system. This, if I understand aright, is Mr. Edison's proposed mode of illumination. The electric force is at hand. Metals sufficiently refractory to bear being raised to vivid incandescence are also within reach. The principles which regulate the division of the current and the development of its light and heat are perfectly well known. There is no room for a "discovery," in the scientific sense of the term, but there is ample room for the exercise of that mechanical ingenuity which has given us the sewing-machine and so many other useful inventions, and which engages a greater number of minds in the United States than in any other nation in the world. Knowing something of the intricacy of the practical problem, I should certainly prefer seeing it in Mr. Edison's hands than in mine.[1]

It is sometimes stated as a recommendation to the electric light, that it is light without heat; but to disprove this it is only necessary to point to the experiments of Davy, which show that the heat of the voltaic arc transcends that of any other terrestrial source. The emission from the carbon points is capable of accurate analysis. To simplify the subject, we will take the case of a platinum wire at first slightly warmed by the current, and then, through the gradual augmentation of the latter, raised to a white heat. When first warmed, the wire sends forth rays which have no power on the optic nerve. They are what we call invisible rays; and not until the temperature of the wire has reached nearly 1,000° Fahr. does it begin to glow with a faint, red light. The rays which it emits prior to redness are all invisible rays, which can warm the hand but can not excite vision. When the temperature of the wire is raised to whiteness these dark rays not only persist, but they are enormously augmented in intensity. They consti-

[1] More than thirty years ago the radiation from incandescent platinum was admirably investigated by Dr. Draper, of New York.

tute about 95 per cent. of the total radiation from the white-hot platinum wire. They make up nearly 90 per cent. of the emission from a brilliant electric light. You can by no means have the light of the carbons without this invisible emission as an accompaniment. The visible radiation is, as it were, built upon the invisible as its necessary foundation.

It is easy to illustrate the growth in intensity of these invisible rays as the visible ones enter the radiation and augment in power. The transparency of the simple gases and metalloids—of oxygen, hydrogen, nitrogen, chlorine, iodine, bromine, sulphur, phosphorus, and even of carbon—for the invisible heat-rays is extraordinary. Dissolved in a proper vehicle iodine cuts the visible radiation sharply off, but allows the invisible free transmission. By dissolving iodine in sulphur, Professor Dewar has recently added to the number of our effectual ray-filters. The mixture may be made as black as pitch for the visible, while remaining transparent for the invisible rays. By such filters it is possible to detach the invisible rays from the total radiation, and to watch their augmentation as the light increases. Expressing the radiation from a platinum wire when it first feels warm to the touch—when, therefore, all its rays are invisible—by the number one, the invisible radiation from the same wire raised to a white heat may be five hundred or more. It is not, then, by the diminution or transformation of the non-luminous emission that we obtain the luminous; the heat-rays maintain their ground as the necessary antecedents and companions of the light-rays. When detached and concentrated these powerful heat-rays can produce all the effects ascribed to the mirrors of Archimedes at the siege of Syracuse. While incompetent to produce the faintest glimmer of light, or to effect the most delicate air-thermometer, they will inflame paper, burn up wood, and even ignite combustible metals. When they impinge upon a metal refractory enough to bear their shock without fusion, they can raise it to a heat so white and luminous as to yield, when analyzed, all the colors of the spectrum. In this way the dark rays emitted by the incandescent carbons are converted into light rays of all colors. Still, so powerless are these invisible rays to excite vision that the eye has been placed at a focus competent to raise platinum-foil to bright redness without experiencing any visual impression. Light for light, no doubt, the amount of heat imparted by the incandescent carbons to the air is far less than that imparted by gas-flames. It is less because of the smaller size of the carbons, and of the comparative smallness of the quantity of fuel consumed in a given time. It is also less because the air can not penetrate the carbons as it penetrates a flame. The temperature of the flame is lowered by the admixture of a gas which constitutes four fifths of our atmosphere, and which, while it appropriates and diffuses the heat, does not aid in the combustion; and this lowering of the temperature by the inert atmospheric nitrogen renders necessary the combustion of a greater amount of gas to produce the

necessary light. In fact, though the statement may appear paradoxical, it is entirely because of its enormous actual temperature that the electric light seems so cool. It is this temperature that renders the proportion of luminous to non-luminous heat greater in the electric light than in our brightest flames. The electric light, moreover, requires no air to sustain it. It glows in the most perfect air-vacuum. Its light and heat are therefore not purchased at the expense of the vitalizing constituent of the atmosphere. It sheds its light without vitiating the air.

Two orders of minds have been implicated in the development of this subject: first, the investigator and discoverer, whose object is purely scientific, and who cares little for practical ends; secondly, the practical mechanician, whose object is mainly industrial. It would be easy, and probably in many cases true, to say that the one wants to gain knowledge, while the other wants to make money; but I am persuaded that the mechanician not unfrequently merges the hope of profit in the love of his work. Members of each of these classes are sometimes scornful toward those of the other. There is, for example, something superb in the disdain with which Cuvier hands over the discoveries of pure science to those who apply them: "Your grand practical achievements are only the easy application of truths not sought with a practical intent—truths which their discoverers pursued for their own sake, impelled solely by an ardor for knowledge. Those who turned them into practice could not have discovered them, while those who discovered them had neither the time nor the inclination to pursue them to a practical result. Your rising workshops, your peopled colonies, your vessels which furrow the seas; this abundance, this luxury, this tumult"—"this commotion," he would have added, were he now alive, "regarding the electric light"—"all come from discoverers in science, though all remain strange to them. The day that a discovery enters the market they abandon it; it concerns them no more."

In writing thus Cuvier probably did not sufficiently take into account the reaction of the applications of science upon science itself. The improvement of an old instrument or the invention of a new one is often tantamount to an enlargement and refinement of the senses of the scientific investigator. Beyond this, the amelioration of the community is also an object worthy of the best efforts of the human brain. Still, assuredly it is well and wise for a nation to bear in mind that those practical applications which strike the public eye, and excite public admiration, are the outgrowth of long-antecedent labors begun, continued, and ended under the operation of a purely intellectual stimulus. "Few," says Pasteur, "seem to comprehend the real origin of the marvels of industry and the wealth of nations. I need no other proof of this than the frequent employment in lectures, speeches, and official language of the erroneous expression, 'applied science.' A statesman

of the greatest talent stated some time ago that in our day the reign of theoretic science had rightly yielded place to that of applied science. Nothing, I venture to say, could be more dangerous, even to practical life, than the consequences which might flow from these words. They show the imperious necessity of a reform in our higher education. There exists no category of sciences to which the name of applied science could be given. We have science and the applications of science which are united as tree and fruit."

A final reflection is here suggested. We have among us a small cohort of social regenerators—men of high thoughts and aspirations—who would place the operations of the scientific mind under the control of a hierarchy which should dictate to the man of science the course that he ought to pursue. How this hierarchy is to get its wisdom they do not explain. They decry and denounce scientific theories; they scorn all reference to ether, and atoms, and molecules, as subjects lying far apart from the world's needs; and yet such ultra-sensible conceptions are often the spur to the greatest discoveries. The source, in fact, from which the true natural philosopher derives inspiration and unifying power is essentially ideal. Faraday lived in this ideal world. Nearly half a century ago, when he first obtained a spark from a magnet, an Oxford don expressed regret that such a discovery should have been made, as it placed a new and facile implement in the hands of the incendiary. To regret, a Comtist hierarchy would have probably added repression, sending Faraday back to his bookbinder's bench as a more dignified and practical sphere of action than piddling with a magnet. And yet it is Faraday's spark which now shines upon our coasts, and promises to illuminate our streets, halls, quays, squares, warehouses, and, perhaps at no distant day, our homes.

THE AARD-VARK OR EARTH-HOG.[1]

By E. OUSTALET.

IN the class *Mammalia* the order *Edentata* is one which offers a very great diversity. To judge from their name, the Edentates should all be animals without teeth; yet, though some of them, as the ant-eater and pangolin, offer this peculiarity, others, on the contrary, as the sloth, the armadillo, and the orycteropus or earth-hog, have the jaws provided with organs of mastication, except the portion where the incisors should be. Again, the nails which terminate the digits of the Edentata are sometimes sharp and hooked, so that the animal may climb easily and suspend itself from the branches of trees; again, they are spade-shaped, so that the animal may excavate the ground. Finally, while in some

[1] Translated from "La Nature," by J. Fitzgerald, A. M.

the integument is reënforced by bony concretions, in others it is covered with imbricate scales, in others clothed with coarse hairs, and in others still perfectly nude. From all this it results that naturalists are greatly puzzled when they have to name the general characteristics of the order. Nevertheless, it may be said that these mammals bear in their skeleton and in the arrangement of their viscera certain signs of inferiority; that their salivary glands are highly developed, a fact accounted for by their insectivorous diet; and that in their circulatory system they present some peculiar features, certain interlacings of the blood-vessels which regulate the flow of the blood to the limbs, which latter usually move with extreme slowness. Furthermore, it may be added that, in Edentata with teeth, those organs have a peculiar aspect, being for the most part void of enamel, and, to all appearance, consisting of a number of cylinders standing side by side.

In the animal world as at present constituted the Edentata are all of medium or even small size; but in former geological epochs they attained very considerable dimensions, rivaling even the elephant. The megatherium, whose bones have been found in Buenos Ayres, was 4½ metres (14¾ feet) in length, and 2¼ metres (6¼ feet) in height; and the megalonyx and the mylodon, found in the same locality, were also of gigantic proportions. And it is curious to observe that America, where the remains of these great creatures are found, is still the continent which possesses the greatest abundance of animals belonging to this order. The Old World, on the other hand, possesses only a few species, and Australia none at all, the part of the Edentata being in that strange country played by the Monotremata, Echidna, and Ornithorhynchi.

Some species of the Edentata are well known to our readers. The armadillo and the pangolin are common in our zoölogical gardens; the ant-eater and the sloth are to be seen there too, though far more rarely. But besides these familiar species, there are others which, till recent times, were all unknown in menageries, and of which but a very imperfect idea could be formed from the stuffed specimens in the public collections. To this class belongs especially the orycteropus, or earth-hog, a curious sort of Edentate from tropical Africa, which several travelers, and among them Von Heuglin, had vainly tried to carry to Europe alive. Two or three months ago, however, the Paris Museum of Natural History was so fortunate as to secure an animal of this genus. It is quartered in the monkey-house, sheltered from the cold, and there, no doubt, it will be able to live for some time to come in captivity.

The traveler Kolbe, about the middle of the eighteenth century, was the first to publish some notices of the orycteropus, already known even at that time to the Dutch settlers under the name of aard-vark (earth-hog); a little later Camper procured the skull of one of these animals, and studied its osteological character; but to Étienne Geoffroy Saint-Hilaire belongs the credit of having clearly pointed out the essential

differences which distinguish the orycteropi from the ant-eaters of the American Continent.

The specimens in our museums and the engravings hitherto published in works of natural history give a very imperfect idea of the orycteropus. In the stuffed specimens—the only models the designer

had at his command—the skin was greatly distended, and the body was disproportionately long. As will be seen from the accompanying figure, drawn from life, the orycteropus is, on the contrary, of heavy build,

with arched back, like a pig, which animal it further resembles in that its skin is sparsely strewed with hairs. But its very long ears, instead of being pendent like those of the pig, rise like horns on both sides of the head; neither is the tail slender or twisted into a corkscrew curl; on the contrary, it is of conical shape and very thick at the base. Finally, the rather elongated head, terminating in a regular snout, has at its extremity a buccal opening rather larger than in the ant-eater, but yet far smaller than in swine. The teeth, numbering five or six pairs in the lower jaw and six or seven in the upper, increase in size from the first to the one before the last on each side. Their structure is peculiar, being far less dense than in most Mammalia, and having no coating of enamel. The grinding surface is flattened, and the single root is pierced with a number of holes in its periphery. The slender, protractile tongue is, as in nearly all of the Edentata, covered with a viscous substance designed to secure the small insects on which the animal lives. The short, heavy feet terminate, the anterior in four digits, the posterior in five, all armed with strong, hoof-like claws. In the posterior feet, as in the anterior, the external lateral digits are a little shorter than the others.

The family *Orycteropidæ* comprises only a single genus, in which we can, not without much difficulty, distinguish three species, viz.: the Cape orycteropus or earth-hog, the one first known; the orycteropus of Senegambia, described by Lesson; and the orycteropus of Ethiopia, studied by D'Abbadie and D'Arnaud on the banks of the White Nile. These three species are identical in their habits, of nearly the same size, 1·3 metre (about 5¼ feet) from the snout to the extremity of the skin, and of the same general form; they differ only in the proportions of the cranium and of the limbs, and in the color and appearance of the skin. Thus, in the Cape orycteropus, for instance, the surface of the body presents a scanty covering of straight, soft hairs, which are shorter on the back than on the belly. In the orycteropus of Ethiopia, on the other hand, the skin is almost perfectly nude, with merely a few straggling, brownish hairs on the ears, the tail, and the base of the limbs. To this species belongs the individual recently acquired for the Jardin des Plantes, and of which our figure is a faithful portrait. It will be seen that the body is swollen like a full skin-bottle, and furrowed with creases which radiate from the abdominal region between the paws. The latter are of enormous size, and the tail, which is soft and flabby, falls to the ground by its own weight. The general appearance of the animal is at once mean and grotesque. Looked at from behind, it resembles a bag, the long ears projecting on each side being the ends of the string by which the mouth of the bag is tied.

This orycteropus lives in pairs in the plains of Kordofan, where it is called by the Arabs *abudelatif*, i. e., "the father that owns claws." In the daytime it lies hidden and doubled up in a deep hole, which it digs in the loose soil of the plain by means of its broad, sharp claws. Toward

evening it quits this hiding-place and begins to move about, advancing either by leaps, or else with an unsteady gait, walking nearly always on the extremities of its digits. Whatever may have been written heretofore by naturalists, the orycteropus is in fact digitigrade rather than plantigrade. When the animal is walking the head is inclined, the snout nearly touching the ground, the ears laid half-way back, and the tail trailing. From time to time the animal stops to listen: it is guided principally by hearing and smell, and by the same means contrives to escape from its enemies. On finding a path that has been traveled over by ants or termites, it follows it up to the ant-hill; having reached the latter, it attacks the structure with its paws, making the dust fly all around, and digging rapidly till it comes to the center, or at least to one of the principal streets. Then, alternately exserting and retracting its viscous tongue, it devours the ants by the thousands. Having made an end of one nest it attacks another, and so on till its hunger is appeased. When we consider the alarming rate at which ants and termites multiply, and the damage they cause, we must recognize in the orycteropus one of the most efficient of man's auxiliaries in tropical regions.

The orycteropi are extremely timid: at the slightest noise they try to get underground. If they find no suitable hole or crevice, then they quickly dig for themselves a hiding-place. The late J. Verreaux, who had many a time observed orycteropi at the Cape, has told me of how, having once seized by the tail one of them when it had got but half of its body underground, he could not get the animal out except by having the ground dug to a considerable depth. In eastern Africa the negroes, approaching cautiously, kill the orycteropus by a sudden thrust of a lance before it has time to disappear. In Senegal, on the other hand, the animal is caught in iron traps, or hunted with dogs by night. The skin of the animal is thick, and makes good, strong leather. The flesh is by some travelers described as juicy, with a taste like that of pork; according to others it is disgusting, being strongly impregnated with ant-odor. Levaillant could never bring himself to eat of it.

In captivity the orycteropus seems stupid, passing most of the day in sleep, rolled up into a shapeless mass. The individual at the Jardin des Plantes, since winter came in, never quits its nest till about five or six o'clock in the evening. Then it begins to roam about its quarters, returning constantly to the stove, where it warms itself with evident pleasure while it squats on its hind legs and keeps its snout steadily pointed at the fire.

SCIENCE AND SOCIALISM.[1]

By Professor OSCAR SCHMIDT,
of the University of Strasburg.

I MUST assume it to be generally known that in last year's Congress of German Naturalists and Physicians, held at Munich, a prominent member incidentally referred to the points of contact between Socialist Democracy and Darwinism, as also to the momentous and redoubtable consequences which might thence ensue. These words of certainly well-meant admonition were received with delight by all those who in any event can not tolerate the doctrine of descent, and who accordingly heartily approved of making Darwinism responsible for the most exciting social phenomenon of the time.

It is, of course, all right enough if certain representatives of Socialist Democracy think they can with the aid of Darwinism add force to their opinions; but they jumble together doctrines which either are irrelevant, or which mutually exclude one another.

This fact, indeed, is recognized by another portion of the Socialist-Democratic party, who hold that the socialistic idea must have supplanted the Darwinian principle as applied to the human race, before the new form of society can be realized and made to stand.

The political economists have now for more than a century been studying the "Struggle for Life" in its bearings on the weal or woe of mankind, yet not until the advent of Darwin did they consider the problem understandingly. Under what forms individuals and classes compete with one another; in what way this struggle is to be ennobled for the benefit of the race—these and other like questions are agitated on all sides, as witness one work among many, namely, A. Lange's thoughtful book, "On the Labor Question" ("Ueber die Arbeiterfrage"). It is not, therefore, with this well-known point of contact with Darwinism that we have to do, but with the special application of ostensibly Darwinian results to the justification and the execution of the Socialist-Democratic programme.

Although it has been raining "Quintessences of Socialism" for the instruction of the public, nevertheless we must briefly explain how far Socialist Democracy, as realized in the future, purports to be the ultimate term of a natural development.

Having passed through the period of absolute Inculture, a period which might be roughly characterized by community life in troops and minor family groups under the leadership of strong male individuals, traces of which are found in the mammoth and reindeer caves, man next entered the less rude condition of the hunter and the nomad where-

[1] Translated from the "Deutsche Rundschau," by J. Fitzgerald, A. M.

in those minor groups, now developed into clans, rose above the primordial state by their complex organization, their division of labor, and their larger enterprise. But now, as we read in the writings of the Socialist Democrats, with distinction of classes and the institution of personal slavery opens the first epoch of human civilization. In this slavery period the whole man is an instrument of labor, and with all his faculties he is the property of the owner who commands his entire service.

In the second civilization period, characterized by handicraft and the possession of land on the small scale, the still widely diffused custom of socage or compulsory service is a reminiscence of the suppressed institution of slavery. The working people are now burgesses enjoying personal freedom, yet hindered in their spontaneous development by the guild. These craftsmen and workers of the soil are the owners and masters of the implements of their calling. Still they do not attain true enjoyment of life, inasmuch as their whole time is engrossed with mechanical toil, in order to procure a livelihood.

The third estate becomes emancipated from the control of the aristocracy of landlordism, the nobility, and the Church. But already the factory system, the system of production by division of labor, was in operation—a system which strips the workman of his little property, and places him under the control of capital.

The factory system is transformed into machine industry. The simpler tools and machinery of early times, worked by hand, have been in the present century developed into a vast complicity of machines producing motion, transferring motion, and doing the work of mechanical tools. These machines tie the workman fast to themselves, reduce his personal service to a minimum of manipulations, and complete the physical and moral wretchedness of the laboring population by increased employment of women and children.

Machinery is an instrument for the accumulation of capital, and of capital as "unpaid labor" at that.

The development of the various forms of production down to the present time when private capital rules everything, and when small capitalists have no chance as against the great, has been vividly portrayed by Marx. He regards the development of the economic social forms as a natural-history process. ("Capital," page 7.) The proposition on which the whole matter hinges, namely, that regarding "unpaid labor," has the appearance of being so simple and so true, that even to many among the laboring class the grand conclusion appears evident, namely, that "the doom of capitalistic private property is about to be sealed. The expropriators will suffer expropriation." (Ibid., page 793.)

Here we see set forth as the natural consequence of development the violent introduction of the Socialist-Democratic state. With the rise of that form of polity the domination of private capital comes to

an end; machinery is no longer private property, but it, with all the other instruments of production, with all that which is understood by the term capital, is transformed into collective or state capital. Private production gives place to collective production. With the abolition, not indeed of all private property, but of all private capital in so far as the same is employed as a means of production, universal participation in the fruits of the collective production, in the means of enjoyment, and in the higher good things of life, is accorded to the whole race.

In this stage of future development the Socialist idea is fully realized. We will not dwell any further on the happy state of things which they say is sure to come about.

If any one would learn more concerning this "picture of fancy," as Socialism is innocently named in one of its chief organs, he may consult Leopold Jacoby's book, "The Idea of Development" ("Die Idee der Entwickelung," 1874, page 6), where he will find it painted in glowing colors. Or he can get a notion of what it is from Engels's most recent utterances (Eug. Dühring's "Science revolutionized"—"Die Umwälzung der Wissenschaft," 1878).

It would be a great mistake to suppose that in the camp of the Socialist Democrats we must find the state of the future represented as a refined copy of a type belonging to the brute creation: on the contrary, Socialistic writers stoutly maintain that the principle of development implies reconstruction. Nevertheless, for the sake of completeness, we will glance at the animal world and consider there the relations between private and collective capital and private and collective production.

Most animals labor for themselves alone. Their implements of labor (private capital) are represented by their members and their weapons of offense; their gains they employ to sustain life. They gather not into barns. Only among the higher classes of animals do we find association of labor and care on the part of the parents for the welfare of their posterity—instincts which can be regarded as confirmed and inherited habits, for all these instinctive actions resolve themselves into labor with gradually accumulated, inherited private capital.

The consociation of higher animals may have the look of work in common, and not instinctive, as for instance when wolves hunt in packs to obtain food, or when animals graze in herds—a habit originating in the need of mutual protection. The colony structures of beavers, the massed nests of the republican bird, are socialistic improvements, in the case of the beaver made under unfavorable outward conditions, and hence *apparently* the result of the animal's voluntary action.

This deceptive appearance is wanting in the structures of the inferior animals, where societies are formed through propagation by budding, the progeny remaining connected with the mother organism. The single individual of a colony of polyps enjoys not only protection against mechanical injuries in the polypidom secreted by all for all, but

further, in case its local position in the polypidom is unfavorable for taking in food, it is fed by the collective alimentary canal, into which flows the surplus of the individual production. A still more complicated social condition, with strict division of labor, is seen in the jelly-fish known as the "Portuguese man-of-war."

I call attention to these familiar facts in order to show that in the animal kingdom communism and socialism are all the more pronounced the lower the organization of the groups among which they appear; and that, on the other hand, wherever among the higher animals conditions occur which savor of the socialistic principle, in the division of the results of the collective production, the egoism of the individual appears all the stronger. I do not at all mean hence to conclude that the case can not be otherwise in human society.

From the selflessness of the polyp to the egoism of the wolf is a development. How this development has been brought about, and how man must come under its action, Darwin teaches; and Leopold Jacoby tells us that the already quoted gospel of the Social Democracy, namely, Marx's work on "Capital," is "a continuation and complement of Darwin's 'Origin of Species' and his 'Descent of Man.'"

This same opinion was expressed one year earlier in "The People's State" ("Der Volksstaat," 1873, No. 31), and it is now our task to examine into its ground.

The only passage in which Marx himself speaks of any complement of Darwinism, though not in connection with his own researches, but *à propos* of the need of a special history of technology, is where he says: "Darwin has drawn attention to the history of natural technology, that is, the formation of plant and animal organs as production-instruments for the life of animals and plants. Should not equal attention be given to the history of the formation of the production-organs of man in society, seeing that these organs are the material basis of every special society organization?" ("Capital," page 385.)

But the scientific method, that of proving by facts the relations between phenomena, is employed by Marx; and in my opinion he is in the right when he protests against the supposition that his dialectic method is at bottom Hegelian. But neither does he collect all the facts—for example, he knows only on the one hand the oppressor and the extortioner, and on the other their victims reduced to misery—nor does he refrain from gratuitous assumptions, as for instance that of the "Unpaid Labor," the most momentous of them all. Again, it happens that, from his not understanding the results of the doctrine of development, the true and actual relations of sociology to Darwinism are hidden from him. For example, he says that "in reality each special historic mode of production has its own special and historically valid laws of population. An abstract law of population holds for plants and animals only in so far as man does not interfere."

Engels, in the work already quoted (page 491), repeats a similar

proposition; but it is not correct, if we use the term "law" in the one sense permitted by exact natural science. The conditions of propagation among plants and animals, the results of their multiplication, vary according to circumstances; and man with his experiments in breeding does not correct Nature, he only copies her. It is plainly out of the question here to speak of laws of population; it were better instead to say that the conditions of population in each period are the effects of special, variable causes peculiar to each stage of development. Cases which are the result of varying circumstances and events are not laws, nor do they justify us in inferring fixed laws.

The attempt has been made, not indeed by Marx himself, but by one of his followers, Leopold Jacoby, to connect logically, in one continuous process, social evolution and its ultimate term, the Socialist-Democratic ideal, with nature's evolution.

He does the impossible with a sophistical argumentation that reminds us of Hegel's dialectic: he is an enthusiast, but it is not for me to pass judgment on his services to Socialist Democracy. Plainly he is an *enfant terrible* for his party. His scientific ideas are of the narrowest kind. Nevertheless, we must reckon with him, since he is the only Socialist-Democrat writer who makes any pretense to observe scientific method in this matter, i. e., the connection between the theory of development and Socialist Democracy. We will later consider Engels's relation to that subject.

Social evolution is nowadays represented by the leaders of Socialist Democracy as being a process of perfectionment necessarily progressing toward a definite end; and as, rightly enough, they do not divorce man from nature, it is plainly their purpose to discover oneness and continuity in social and in natural evolution.

Revolution, say the Social Democrats, is correction of perverted conditions or re-formation for the sake of improvement. Copernicus happily expressed this idea when he gave to his work which upset the astronomical notions of his time the title "De Revolutionibus." It is of no consequence whatever that this is not the true title of the book, but "De Orbium Cœlestium Revolutionibus," or that "revolutio" means a turning round and not an overturning.

In short, in these revolutions, as the Socialist-Democratic philosophy further teaches, "we recognize an ever self-perfecting origination and formation of things in the universe": so much we learn from Kant and Laplace. Then came Lamarck with the "doctrine of the continuous and successive development of organic beings on the earth," but for half a century he failed to obtain a hearing till Darwin procured for the doctrine full acceptance. Thus we have to thank Lamarck and Darwin for the fact that we understand the nature of the two great "revolutions," whereof the one produced the existence of organisms in the transition of the inorganic into the organic, while the idea of the other had for its object the appearance of man.

Thus the philosophy of Social Democracy resembles that of Plato, in teaching that the *idea* hovers over the bodily form. It is the *idea* that dominates everywhere, determining the forms of all things. Hence, down to the advent of man there was in nature a steady, thorough, unconscious striving.

And here comes in another great revolution, the third—viz., the universal apparition of the consciousness of the human race, the philosophical establishment of which is the task which Marx has set himself. Thus, then, as we read in the "Volksstaat" (*ubi supra*), "Darwin and Marx have, by their profound and ingenious researches, carried on in totally different scientific fields, attained results of the utmost importance to mankind, and which, being intimately correlated, mutually support and complement one another."

As Social Democracy holds the accomplishment of its ends to be inevitable and necessary, so, as we have seen, it is one of its cardinal principles that all the phenomena which take place in matter, and all developments of matter, are prefigured and predetermined in the idea. The honest workingman thus learns that a statue is less successful, the less conscious the sculptor was of the idea of the work of beauty inherent in the marble block, and the more he suffered himself during his labor to be influenced by considerations of profit and the like. "In this example of the sculptor and his work, we have," says Jacoby, "a direct proof (direct proof!) of the truth of the proposition that ideas are contained in unconscious nature."

I shall be asked whether the utterances just recounted represent the sympathy between Socialist Democracy and Darwinism—whether these abstract and rather curious and confused theses and propositions represent the dangerous elements, that is, the politically dangerous elements imported into Socialist Democracy from the development theory.

With a few additions, which we will make further on, they do!

How, then, does Darwinism stand with respect to these cardinal ideas of the socialistic development doctrine, as laid down by a philosopher of that school?

We find here two ideas wherein Socialist Democracy purports to be at one with the scientific doctrine of Evolution, viz., Development or Revolution is re-formation—i. e., correction of perverted conditions; and All development has for its basis an idea which designates the future goal, and which governs the movement toward the same. In themselves these propositions are plainly innocent enough, and if they were a result of Darwinian research, they need not be disowned. But Darwinism disclaims the honor of having established any such principles.

What we call *origin*, or *development of species*, is in the first place not a reversal of perverted conditions. In such play upon words we have never indulged. The Darwinian principle of development is Natural Selection, and people are not wont to select from perverted types. It is true that the struggle amid which selection goes on includes also

the struggle against wrong, when it is waged consciously, but generally it is a *struggle against environment.*

We have first to take into consideration the downfall of the one that struggles. But nature, or if you choose the law of nature, recognizes here no distinction of right and wrong: the question is purely one of might. That one is defeated who possesses the least means, the least amount of fight-capital, however sufficient and abundant the same might be under circumstances different from those here and now prevailing. Certainly no scientific man has ever dreamed of subsuming this case under the Hegelian phrases evil—good, negation—position, perversion—correction, etc.

The opposite of this first instance of the outcome of the struggle for existence is seen where one party, by a process of gradual perfectionment, prevails over its opponents and the environment. To the philosopher who is searching for analogies, this appears to be the practical fulfillment of the idea of perfectionment. Still, these two extremes do by no means exhaust every possible termination of the struggle; for there is another possible issue—one which, though it be overlooked by the Socialist-Democrat philosophers, is nevertheless of enormously frequent occurrence: *the organism that makes the struggle adapts itself to the environment.* In doing this, it must oftentimes pass through such straits that it parts with some of its perfections and falls to a lower grade, like many a European baron who has in America found use for himself as a cook's assistant. Or it so remolds itself and its habits in adapting itself to the environment that, while it in no wise becomes more perfect, it nevertheless, as far as possible, insures for the future its present rank.

Thus, to illustrate by an example, it has been observed that, as a rule, birds of brilliant plumage, which on that very account are more conspicuous objects to their enemies, are far more careful to conceal their nests than birds which are not so conspicuous. This we explain on the theory that the ancestors of the bright-colored species by degrees became wise by experience, and that this experience, reënforced by habit, was transmitted to their progeny by heredity. Natural selection keeps pace with experience and habit. In the case of these birds, the change in nesting is a step of progress, but they have not thereby gained any perfection.

If in the historic evolution of organic nature we saw progress only, we should be strongly tempted to regard progress, pure and simple, as a universal natural law for social development as well. But the lesson taught us by birds of brilliant plumage (to say nothing of the loss of acquired perfection) is repeated throughout the whole world of lowly and lowest organisms. These have stood stock-still and must so remain, despite the perfection attained in many directions. The persistence of the low and the imperfect finds its very simple explanation in the persistence of its universally prevailing life-conditions. Millions and mil-

lions of lowly species have perished one after another, giving way to better, i. e., to stronger; and many millions whose slightly variant ancestors escaped from their enemies and rivals have survived. A sea peopled only by fishes, or the land only by mammals, is something unnatural. Thus, the imperfect endures; the perfect, the homogeneous, left to itself alone, becomes self-destructive, as the New-Zealanders began to prey on each other so soon as they had exterminated their only edible wild animal, the dinornis.

In short, Darwinism shows that the evolution of organic life is not to be summed up in a few abstract formulæ. It calls attention to the fact that with the gradual succession of species goes on, *with other movements*, a slow perfectionment in different directions; and this necessary but yet only *partial* progress it seeks to explain by "selection of the fittest" in the decay *or* the backwardness of less gifted individuals and species.

In the whole system of Darwinism we find, unfortunately, no hint of a law which shall in advance determine this perfectionment; and it is laughable to observe how, on the one side, people are complaining that we set up Chance on a throne as a universal principle, while, on the other side, people are making the discovery that the guiding principles of the Socialist Democrats, those principles which are shaping the future, are corollaries of the theory of development.

The strength of the Socialist-Democratic teaching lies in this, that the candidates and members of the party, men unpracticed in logical thinking, are sternly schooled in a few principles, and taught to regard the actualization of *the idea* as something necessary *ex necessitate rei.* The fundamental mistake of supposing that Social Democracy has any point of contact with Darwinism arises, as we have explained, out of the supposition that Darwinism too has brought to light ideas which govern organic transformation—such ideas as are supposed to be necessary for calling forth social revolutions.

The Socialist Democrats do away, after their own fashion, with the personal Godhead, and for this, of course, "atheistic science" is held to answer. In L. Jacoby's work we read:

> We call the idea the foreknown existence of the embodied total result of a progressive re-formation. But this foreknowledge can exist in no other way save this, that the thing to which we grant the idea has itself been carried into the progressive re-formation; and from this knowledge follows the other side of the essence of the idea, namely, the being dominated by the idea, the being forcibly moved by the idea in a given direction. If to these first organisms we allow the idea of Man, we *ipso facto* recognize their domination by this idea; in other words, we see how *they have been constrained so to transform themselves as finally to produce from themselves man.*

This thought, stripped of the studied verbiage in which it is here invested, has very generally become rooted in the minds of the Socialist Democrats. In this way they have set up, in the place of a personal

God, a sort of infallible bugbear under the guise of an Omnipotent Idea. The whole thing is misty, mystic, supernatural, in no sense scientific, least of all is it a Darwinian explication of facts.

Darwinism holds the exact opposite of all this, maintaining that development does *not* proceed according to ideas. Darwinism sees in nature only forces, laws, causes, and effects. Ideas it must for the present leave to the philosophers; and, moreover, it has absolutely no points of contact with the doctrine of ideas contained in the Socialist-Democrat catechism. Hence, when the Socialist Democracy bases the realization of its ideal on the fact that men who are conscious of the impelling ideas must irresistibly push on the work, and so carries the masses on into a belief in these ideas, it must itself be held responsible. *As for Darwinism, it gives no encouragement to such imaginings*, and hence must, in this respect, be simply indifferent for all, whether they hate Social Democracy or whether they love it.

But there is a category of scientific men who look on the origin of species as a development of the higher out of the lower; who find the Darwinian principle insufficient; who will have nothing unaccounted for, and who therefore conceal their ignorance under such phrases as "tendency to perfection" or "aiming at an end." I might also refer to the "Philosophy of the Unconscious"—now, as I believe, in process of decay—a philosophy which, whenever it knows not how to explain anything, solemnly invokes the aid of its "Unconscious." Between these muddled auxiliaries and the Socialist Democrat's "ideas which govern revolutions and determine the re-formation of perverted conditions," there exists an unmistakable though perhaps "unconscious" relationship.

There is, then, a point of contact between Socialist Democracy and Darwinism; but, as far as we have examined it, it is seen to rest on erroneous suppositions and ignorance of the essence of the development doctrine. So far we have found it concerned only with a few theoretical propositions; and we have had nothing to say about the practical realization of the Socialistic idea, or of the doctrines which might perhaps be borrowed from Darwinism to add to it strength.

The Socialist Democrats are unanimous in expressing discontent with the social conditions at present existing. But with respect to the specific organization of society in the future their leaders are very reticent. So much is certain, that the great mass of the workingmen, who now have to sell their entire strength for wages that merely suffice to support life, will in the future perform no so-called "unpaid labor." They will have a share in those higher enjoyments the prerequisite condition of which is a higher mental development. Opportunity for attaining this is afforded every one in the Socialist-Democratic state, by a considerable shortening of the hours of purely mechanical toil, and by opening perfectly free schools of every grade. When the whole population has been in this way refined, there is no longer

question of the "rude physical struggle for existence." For since in the time to come each individual will develop his reason, and reason can not endure perversion or wrong, each will labor for all and all for each. Whether, instead of the present division of labor, there will be an arrangement having the same effect, but based on personal inclination and personal fitness ("Zukunft," 1878, page 704); or whether the system of alternation of work will be introduced, so that, as Engels would have it (*ubi supra*, page 173), the man who in the forenoon wheels a barrow is an architect in the afternoon; what is to be done when no workmen offer themselves for certain kinds of labor, while for other kinds there are too many; whether and how the workman is to be entitled to a certain measure of the means of enjoyment according to the nature of his work, or the exertions he puts forth, or his individual needs: these are all open questions. The amicable settlement of these questions presupposes, as we have already observed, a general physical and moral elevation of the individual, of which the present mean intellectual status is but a faint foretaste.

Thus Socialist Democracy demands a more equitable general division of the good things of life, that every one shall have a share in life's pleasures, and it aims to demonstrate the justice and the naturalness of the claim. We are interested in it, inasmuch as appeal is made to Darwinism for its establishment.

The revolution which goes on quietly in Christendom has appealed to the equality which exists beyond the grave. The Revolution of 1789 was more practical, and championed the natural right of the Third Estate—the right of equality and fraternity here on earth. What it was that gave this direction to the revolution, and how it expounded the return to nature and to the truth of which so much was then said, is sufficiently well known. Now, again, as the Socialist Democracy is not alone in affirming, and truly enough too perhaps, we stand on the threshold of a social overturning. Again there is question of an appeal to be made to the inborn rights of man. Next after the basic idea controlling revolution, of which we have already spoken, the Socialistic programme, like the programme of all revolutions which proceed from a general state of distress, insists on the restoration of that equality which is the strictly natural right of every man, but which has been lost, owing to unnatural and perverted social conditions.

The Socialist Democrats are not content with Brentano's view, that humanity's goal is perfection, nor with Held's, that the ideal end of progress is the highest perfectionment of all. Hence they have enlarged the idea of perfectionment by making it include a reduction of labor and an increase of bodily and intellectual enjoyment. That, in the event of a refusal to recognize the justice of this demand, force would be employed to complete its demonstration, is expressed without ambiguity. But it is easy to see how welcome it would be to the leaders of the movement could biology be ranged on their side, and

could Darwinism, "carried out to its logical conclusions," be inscribed on their banner.

If the Socialist-Democratic doctrines had any organic relationship to the anthropological side of Darwinism, science would find its way into it. It would ill befit Science to complain of this. In fact, the Socialist Democrats believe that such alliance has already been effected between science and their philosophy, and it will do no harm to consider the situation, though as conceived by the Socialist Democrats it implies a fundamental misunderstanding.

In the "Volksstaat" (*ubi supra*) we read:

> The Darwinian theory is an important support for Socialism: it is, so to speak, unconsciously its sanction on the part of natural science. For, after all, what is the principal result or the practical meaning of the Darwinian doctrine? Surely, along with a profound insight into the workings of organic nature, it means *the explicit recognition of the doctrine of equality between all men.* If, etc. . . . then surely we may well preach Socialism, inasmuch as every one knows that each individual is a product evolved by nature, and hence having the same claims on nature.

Then the conclusion is drawn that, inasmuch as the reactionaries will not accept the descent of man, they do all they can to prevent the recognition of Darwinism as a support of Socialist Democracy, and to check its diffusion among the people.

How the Socialist Democrats picture to themselves the equality of all men, and first of all the equal natural condition of all men, we see in Jacoby: "Man is good from the beginning"; "The brain of each individual man is capable of being developed so that it shall of itself do all thinking, just as the hand of each individual man is capable of being developed so that it shall do everything with the aid of machinery." That hitherto we have seen only *capacity* for equal development, while *in fact* there exists great inequality of development, is due to the fact that only those who enjoy unnatural privileges have the time requisite for the development of their consciousness. When men shall once have been properly brought up to equality in the Socialistic state, then equal development, with bias toward the good, will come of itself, for "*knowledge of nature compels us to regard all men as beings capable of development in precisely the same measure.*"

But by the term "all men" is to be understood the male portion of the race, for many Socialist Democrats agree with high authorities in holding that woman, by reason of her abnormal brain-structure, must, in the state of the future, act a subordinate part: judgment, action, are not for her, but only feeling, and the faculty of order.

In all this it were difficult to find a single trait that can be referred to the Darwinian anthropology. The Socialist's "aspiration toward perfection" is associated with his ideal of the equality of mankind. Now, *this illusion Darwinism utterly demolishes.* The very principle of development negatives the principle of equality. So far does Dar-

winism go in denying equality, that even where in idea we should have equality, Darwinism pronounces its realization an impossibility. *Darwinism is the scientific establishment of inequality*, and hence the assertion that the Darwinian doctrine is above all a recognition of the doctrine of the equality of all men needs no refutation from our side: it has no foundation in fact.

Again, nowhere in the literature of Darwinism do we find the axioms that "every man is from the beginning good," or that "all men are equal in their capacity for development."

As to what the Darwinians think, let me quote from my book, "Darwinism and the Doctrine of Descent": "The grade to which this (intellectual) development rises is generally dependent on the preceding generations. The psychical capacities of each individual bear the family type, and are determined by the laws of heredity. *For it is simply untrue that, independently of color and descent, each man, under conditions otherwise alike, may attain a like pitch of mental development*" (page 296).

Had it not been that we are held answerable for these ideas of the Socialist Democrats, we should never have esteemed them worthy of notice.

The Socialist Democrats anticipate, when their state shall have been founded, the universal contentment of all men, who shall labor partly out of personal inclination, partly by state ordinance. For this, good men will surely be needed, for one year after the proclamation of equality, the "Volksstaat" (1874, No. 30) demands that "the strong and the weak, the bright and the dull, force of mind and force of body, in so far as they are human, shall in a partnership such as befits human beings be associated in labor, and associated in the enjoyment of its fruits."

Here we must consider that fraction of the Socialist Democrats who with Engels (*ubi supra*, pages 223 *sqq.*, and especially page 235) imagine that the inequality which man inherits from his brute origin, *an inequality that can not be done away*, will be paralyzed under the new social order. As we have seen, some of the Socialists deduce the inequality of human individuals from the unnaturalness of the old form of social organization; they not only maintain a vague idea of equality, but they also expect to see an equal development of individuals, though strong and weak, bright and dull, still continue.

On the other hand, Engels calls the advanced advocates of equality "ghosts," and the demand of the proletariat for an equality beyond the abolition of class, an "absurdity" (page 84); at the same time he is confident that the struggle for existence will cease on the abolition of class distinctions, and will give place to universal mutual good will. This would require that individuals should disregard all actually existent inequalities, whether mental or bodily. Plainly there is no Darwinism here either, and we leave it to others to contest this conversion of the

doctrine of development, a doctrine grounded on observation, into a fiction of the imagination, for we have to do, not with Socialist Democracy as such, but with its relation to Darwinism.

The result of our investigation is, that Socialist Democracy, wherever it appeals to Darwinism, has failed to understand that hypothesis; that, if it has understood it, it knows not how to draw from it any advantage for itself; and that it must deny the unalterable principle of Darwinism, namely, competition.[1]

Such is an account of our relations to Socialist Democracy, a movement whose gravity we look on as a sign of a diseased social state that calls for help and salvation.

It remains to define our position with respect to the views of a few of the friends and counselors of the Socialistic movement who, approaching more nearly to the Darwinian point of view, look for the best results for human progress to result from natural selection *after* present social ills have been cured. I refer in particular to Albert Lange. That so eminent a student of human life should estimate at its true value the struggle for existence which has come down to humanity from the unconscious animal world, was to have been expected. He well knew how little warrant there is for the expectation that the "struggle for the more desirable position" will ever cease. But he based his hope on the idea of liberty and equality, an idea that is slowly developed with the developing reason, and which brings men together, in spite of differences of race, or talents, or station. He hoped that the laws of the conscious intelligence would, as time went on, gain the mastery. He hoped for a deliverance to come in the very remote future from a current of thought and feeling which would arise in the developed human mind, and which would run counter to the natural process of differentiation and division. He hoped for a spiritualization of the physical struggle into a peaceful contest, having for its object the good of the race. It is therefore nothing new if in these days like views are put forth by Socialist Democrats.

In his work "The Labor Question," Lange has intimated that certain social evils are the results of artificial selection, and that these might be corrected by a return to simpler natural conditions. If we were to spin out this thought, as is done, for instance, by Dodel in his "Neuere Schöpfungsgeschichte" (1875, pages 145, 147), we might readily persuade ourselves that under the social conditions now existing the principle of natural selection, indeed any purely natural development, "comes into operation either not at all, or only to a limited extent." Then it seems to be an infraction of the natural order, that they who are born to station, so often, without personal worth or talents, monopolize, in virtue of their inherited wealth, the pleasures and enjoyments of life, leaving for their descendants the same even path.

[1] In the "Zukunft" (1878, *ubi supra*) the competition of the future is narrowed down to "a competitive struggle between natural gifts."

Do these favorites of Fortune, it is asked, who take no part in the struggle for existence, constitute the portion of society which is most highly endowed by nature? Ought we to foster such a class for generations to come? In fact, can it be that its continued and prosperous existence has the highest justification?

Out of this preposterous condition of things, where the salutary principle of natural selection is borne down by artificial selection, our one hope of deliverance, we are told, is in the coming of a time "when all the millions who day by day come into existence shall enjoy equal rights of development, so that each individual favored of Fortune, be his birthplace a hovel or a palace, each one endowed with talent or genius, shall find ready prepared for him all the means requisite for developing his natural powers in proportion to their value, and for afterward employing the same for the common good."

I can not accept as correct this explanation of natural and artificial selection. Each individual has, throughout the whole course of historical development, fortified his existence by all the means at his command, with property, with inherited station, by putting forth all his powers of body or of mind, inherited and personal. Artificial selection has a definite end in view: it aims at transforming for a special purpose that which is offered by nature, and then maintaining the new form for the same end. When the nobility, the great landholder class, maintains its position and becomes rooted, we have not an instance of artificial selection in the Darwinian sense, but it is the *natural course of things*, however unnatural the result may seem to be. If this be not admitted, then the whole education of mankind, and every arrangement in the state or in society made consciously and with the object of adding to man's happiness or developing his powers, must be accounted instruments of artificial selection. And among the most artificial of them all would be a regulation of the state which should insure unlimited freedom of development to each individual's talents.

At our point of view we are ever and again reminded that the idea of the natural struggle for existence does not imply that the victorious one is always physiologically, or, in the case of man, morally, the most deserving. We might, but we can not, imagine an ideal state wherein the most deserving shall always gain the victory, and thus we may represent to ourselves a universal perfectionment as the end of development. Hence we are not in the least pessimists; but, on the other hand, the innumerable evidences of progress which we see in nature, both animate and inanimate, do not suffice to make our idea of the universe purely optimistic. Progress is an asymptote of the ideal of perfectionment, and in recognizing this we give free play to the tendency perfectionward, without attempting on our own part to interfere.

With all the certainty that is attainable by inductive proof, the doctrine of development teaches the brute origin of man. Whether Pfeffel says aright—

Weit besser für das Heil der Welt
Ist frommer Irrthum, der erhält,
Als kalte Wahrheit, die zerstört [1]—

may perhaps be open to question in certain cases. In the present case it is worth while to reflect that oftentimes men who awaken from a long-cherished though pious error betray their kinship to the beasts; while truth, sedulously handed down from generation to generation, and advancing enlightenment, make men more human.

Would that we could diffuse abroad a conception of the full truth of the Darwinian doctrine of development, to the end that every thinking man who has not already been caught by the counter-current might know what it comprises and what consequences it does *not* warrant!

THE FIRST THREE YEARS OF CHILDHOOD.

THE readers of the "Monthly" will remember the account of "An Infant's Progress in Language," by F. Pollock, in our September number. We also published an article on "Lingual Development in Babyhood," by M. Taine, in June, 1876. M. Bernard Perez has just published a book upon an analogous subject—the mental development of children under three years of age. The following *résumé* of his observations is translated from the "Revue Scientifique" for November, 1878.

I. SENSIBILITY: PLEASURES AND PAINS OF THE SENSES.—From the first month the fœtus is sensible to the action of cold. Its nervous system commences to react.

Taste.—The first manifestations of pleasure in infancy are due to taste. A child two months and a half old will refuse with grimaces a sucking-bottle filled with water, or with milk too little sweetened.

Touch.—The feather of a quill passed over the eyes and nose of a child fifteen days old will make it frown. Agreeable sensations are not manifested before the age of two months, although they may exist before that time.

Temperature.—Infants die easily of cold even in summer. It is thought, however, that adults suffer more from cold, because they are better able to compare their different states.

Vision.—Color attracts a babe; lively colors charm it, dull colors also please if they are positive and distinct. Two children, one three months, the other five, were delighted by some sketches of a grayish color.

Hearing.—One child a month old liked to listen to playing and

[1] Far better for the welfare of the world is pious error, which sustains, than cold truth, which destroys.

singing. When four or six months old almost all children like to be sung to, and many try to prattle. They please themselves by making a noise.

Smell.—Children for a long time show no sensibility to good and bad odors. At ten or fifteen months their sense of smell is very lively.

II. SENSIBILITY : EMOTIONS AND PASSIONS.

Taste.—The emotions connected with taste are for a long time the most lively.

Fear.—Fear is early manifested. A babe of two months will make a face, cry, and recoil upon the bosom of its nurse, if one sneezes or cries out near it.

Jealousy and Anger.—A little girl, nearly three months old, would frown, make wry faces, kick, and cry, on seeing another babe on her mother's breast. A little boy, on the second day, when dressed, gesticulated in a manner painful to see, and especially when his arms were put in the sleeves.

Emotions vary with the Objects.—A little child eleven months old was pleased to hold the nursing-bottle, and to eat various foods; he loved to play ; he showed affection for his parents, and made some difference in this respect between different persons that he liked. He showed aversion for some inanimate objects (hammer syringe) ; for a little black barking dog; and for the caresses of a neighboring child seven years old, who had played him more than one trick. The organization of children being more feeble than ours, their emotions are short-lived, and things the most disagreeable or painful do not long remain so.

Animal Sympathy.—Children love animals, but in a purely egotistic fashion. A child six months old, left alone with a turtle, half tore off one of its feet, and when his nurse came was pulling at another with all his might.

Human Sympathy.—One child a year old, coming home after a month's absence, paid no attention to a cat and dog that he knew well, but with a smile reached out his arms to an old servant. Children have only a germ of true sympathy. A little child four years old lost one of his dearest companions. The father of the dead boy took him on his knee while sobbing. The child escaped, frisked about for a little, and, coming back to the afflicted father, said, "Now Peter is dead, you will give me his horse and drum, will you not?" Sometimes more sensibility is manifested : a baby of sixteen months would cry to the shedding of hot tears on seeing his father take a shower-bath. The same child at the same time was the terror of cats.

III. MOVEMENTS (First Period).—The new-born child sneezes.

Cries and Tears.—During its first weeks the babe sheds no tears. In a child seventy-seven days old rapid and short inspirations approached to sobbing ; in another child of one hundred and thirty-eight days M. Perez observed a distinct sob.

Laughing.—Smiling often occurs before the age of a month. Children of two months laugh, but without seeming to suspect that the laugh expresses anything.

Sense.—A little girl three months old would prattle when her mother sang; she had for some time expressed, by particular sounds, her wish to suck.

Various Movements.—A child six days old left, with his arms free, in his cradle, would mechanically carry his hand toward his face, and succeed in placing it almost under his head. We may remark that his father often slept in an analogous position. Children raise and lower their arms and legs with no apparent reason. Some new-born babes move their eyes from the second day. The son of Tiedemann, a philosopher of the eighteenth century, would, when inspiring, suck anything put in his mouth the next day after his birth.

IV. MOVEMENTS (Second Period).—Between four and eight months the child passes over the interval which separates motion and locomotion. Toward the age of fifteen months he executes many movements—shaking his head from right to left to say no, and bowing it to say yes. The ear and eye have accommodated themselves to distances. The eye expresses many shades of thought, feeling, and will. Laughs, tears, and various movements of the hand serve equally to express emotion.

V. VOLUNTARY MOVEMENTS.—The new-born child executes some movements that have a definite end. These movements are probably automatic; consciousness is, however, beginning to awaken. When two or three months old the child can put forth a good deal of strength. At four or five months he will make such a stir that it will take several persons to quiet him. Voluntary action is always determined by feeling more or less conscious.

VI. INTELLECTUAL FACULTIES: CONSCIOUSNESS, ATTENTION.—M. Perez thinks that many reflex actions of the child are accompanied by consciousness. The eyes of a little girl a week old would sometimes take a rotary movement, as if trying to see something. When some one spoke, or when certain objects made a great noise, something like surprise and attention, and an intentional direction to her gaze, was noticed. This little girl would suck, but without persistence, all objects, besides the nipple, that were carried to her lips. She cried and wrung herself when put in her cradle, but if her mother took her in her arms, and while singing put her face against the child's, she would cease to cry.

Attention.—A child of seventeen days would follow with its eyes a lighted candle that was passed before him. Another, at the age of a month, would give sustained attention to the act of sucking; its fixed eyes would shine with pleasure, and would from time to time half veil themselves under his eyelids. His sucking-bottle was filled with sweetened water. After a slight hesitation, he continued his sucking with the same expression of voluptuous attention as if the bottle had

contained milk. When given pure water, he tasted it, left it, took hold again, and then abandoned it, frowning and making a mouth. A child a month old would look fixedly, for three or four minutes, at the reflection in a mirror of the light on a table. In forty-five days he would follow with his eyes a doll dressed in bright blue, that a little girl danced before him a yard off. Thirteen days after his birth the son of Tiedemann gave attention to the gestures of those who spoke to him. The attention of children is very short-lived, but it is often profitable.

VII. MEMORY.—Hereditary memory is manifested in the first reflex actions of the infant. These awaken the consciousness, and the child's own memory often unites itself with them. In a few months a child has already many personal recollections. A little girl three months and a half old could indicate where her feet were; she also distinguished her dress, which she seemed to take for a part of her person. She had a passion for color; the word picture made her smile. A little boy seven months old had a particular tenderness for his grandmother, who had fed him with a bottle. A brush was put before him. He put his hands upon it, and soon lifted them with a grave air. The experiment was repeated several times; at the eighth he threw himself backward, without touching the brush; at the ninth he reflected, hesitated, again drew back, and embraced his grandmother. Memory is also manifested by a sort of intermittent possession of recollections. A little girl eight months old moves her arms as if she were shaking a bell. She is possessed by the idea of this bell, and often amuses herself with it. When she is distracted for a time, she will recommence her movements, and repeat this manœuvre more than twenty times in half an hour. A little child of fifteen months would incessantly repeat the word *a-teau* (bateau), meaning the boat, which he liked very much; later, two hens along with the boat engrossed his attention. Some months afterward he made a journey, and for the two words he had so often repeated he substituted those of *min-fer* (*chemin de fer*, railroad).

VIII. ASSOCIATION OF SENSATIONS, IDEAS, AND ACTS.—When the young Tiedemann, two days old, was placed on his side, in the position for sucking, or when he felt a soft hand on his face, he was hushed, and sought the breast. At five months he had remarked that when his nurse took her mantle it was a signal for going out. So he always rejoiced when that happened. A little child four months and a half old, hearing her nurse call her from behind a door through the keyhole, raised her head, looked right and left, and, at a fresh call, put out her arms, gave starts of joy, of desire, of spite, and finally began to make grimaces. The nurse of a little girl three months and a half old, when going out with the child, bought a bouquet of violets, which she concealed in her bosom. An uncle of the child one day took her in his lap; he had a pretty rose in his button-hole; the child put out her arms, pressed the vest of her uncle with both hands, applied her lips to his shirt front, and made sucking movements. A child of six months

demanded his bottle, with loud cries, the first thing in the morning, even if it had been given him but the moment before. Thus children associate their sensations; and almost all kinds of associations, fortuitous or logical, may be observed among them.

IX. ABSTRACTION.—We may study in little children the analysis which ends in the idea of the individual, and that which ends in the ideas of form and quantity. At the age of one month several children would follow with their eyes an object in motion near their faces. Children learn only little by little to distinguish different colors. External impressions take hold of them by degrees. "Distinctly to perceive sensations, and to preserve the distinct recollection of them, apart from the vague complexity of concomitant impressions, which have only slightly affected the senses, is a work of repair that may be considered as a sort of rudimentary abstraction." Notions of form ought to arise in consequence of the necessity there is that the child should see things separately in order to see them well, and from especially lively impressions made by certain objects. According to Perez, abstraction is not a result of language. Purely abstract ideas do not exist, and relatively abstract ideas have their origin independently of language.

X. COMPARISON.—Comparison, properly speaking, is not possible to the new-born child for several weeks. A little girl of three months, before whom were put an empty sucking-bottle and one full of milk, seized both, and carried the empty one to her lips. A cake and a morsel of bread were placed before a child of ten months. He seized the cake. It was taken away from him, and he began to cry and kick. Presently a morsel of bread was given him, which he took, but did not see his mistake till he had bitten it, when he threw it away. The same child could easily distinguish its own playthings from those of its comrades, and, while glad to get hold of theirs, would not permit them to amuse themselves with his. After fifteen months, and especially between twenty months and two years, children compare a great deal. When about two years and a half they use such phrases as baby tree (little tree), papa tree (great tree). One child three years old knows the names of more than twenty trees, and can give their more apparent specific characters.

XI. IMAGINATION.—Representative imagination is exercised at the beginning of life. Several facts already given prove this. The vague and profound terror manifested by children is a product of imagination, and so are dreams. The passage from reproductive imagination to creative imagination is effected by a change in the order in which the ideas are represented, a change which frequently occurs during sleep. Creative imagination is shown in a waking state by many acts. The child appreciates fun, and sometimes tries to amuse those who surround it. At four months lacking three days, young Tiedemann tried, for amusement, to make all sorts of movements, and to take different postures. The same faculty manifests itself under the form of destructive

and constructive mania. The imitation of gestures, of expressions, of the cries of animals, indicate the first awakening of the æsthetic sentiment, to which, perhaps, we should also attribute the attraction that certain pictures have for the child. A little boy three and a half years old, being admitted for some weeks to play with a dozen little girls four or five years old, chose his favorites the second day. He had a strong affection for two or three children more playful than the others; he would take them in his arms and caress them, while turning away from the others, scolding them and striking them. The same child early showed a sort of æsthetic musical sentiment. When listening to the piano, he would execute rhythmic jerks or starts. At twenty months children are passionate for the recital of impressions suited to them. Even at three years they take in earnest the stories told them, and often, when these stories are repeated, they will not permit any changes of statement.

XII. GENERALIZATION.—M. Perez does not believe that language is necessary to the making of a generalization. He points out to the observer a rudiment of generalization in children that can not talk. A child eight months old had, among his favorite playthings, a tin box, into which he put everything that would go into it. Having found out the property of the box to contain other things, he reasoned from this to unknown objects, and began to experiment. He tried to put the legs of a little dancing jack into the stopper of a decanter, then a little doll's cradle, and finally the end of his forefinger. A child of eight months, at the sight of any young or playful person, would make starts toward her. Besides, even at the time when children express some general ideas by words, they have others which they do not so express. A child of thirteen months, who was refused the hand when he wished to be led, left the person who held him, got down upon the floor, and began to creep. Creeping was for him a means of going along—a means of which he had a very distinct idea.

XIII. JUDGMENT.—If to judge is to believe something of something else, we can not doubt that judgment is manifested by children. The young Tiedemann made a judgment when, seeing his nurse take her mantle, he understood that she was going out. The notion of quantity is early formed by little children, who know very well a large piece of cake from a small one. The idea of number is confounded with that of quantity; a little child of three months seized at the same time two sucking-bottles that were offered him. A child two years and a half old knows how to count twelve, but has not a clear idea of the time represented by three days. In a general way the child often judges very well of concrete matters. Abstract judgments are more difficult for it.

XIV. REASONING.—The little child reasons, if reason is only a series of consecutive judgments arranged according to the law of habitual association. A child seven months old associates the idea of the

movements of mastication, and the resulting sensations. When he sees his nurse eat, he thinks that what she eats is good for her, and that what is good for her will be good for him. And, as he knows by experience that the nurse can divide with him if she pleases, he begins to cry, in order to make her do it. It is very difficult to distinguish that which is conscious from that which is unconscious in the total manifestations of apparently rationally ordered feelings, ideas, and organic impulses. A child whose father often went fishing was accustomed to eat fried fish. One day his father, coming home after the hour of supper, ate alone. "Me want fry, papa; me want fry," said he, seeking to get the attention of his father; he finished by getting under the table, and pulling his father's leg. "Me want fry, not kitty; me fry; me want fry." His idea was to imitate the cat in getting under the table, so as to get some fish. Conscious acts are mingled with reflex acts. Children often show a great aptitude in appropriating the experiences arising in new circumstances. A little child, in the neighborhood of two years old, would sometimes, at the table, steal something from his neighbor's plate. He would at once compare the stolen morsel with his own piece, then he would hurry and compress it, so that his larceny would be less apparent.

XV. Of the Expression of Language.—Language is only a superior application of the faculty of expression possessed by all animals. It is based on the correspondence between certain external movements with experienced sensations. Children from the first month cry, prattle, sob, but without attaching any signification to these acts. Association and a sort of selection render these movements and these feelings conscious and voluntary. Hereditary influence ought to interpose in the early progress of language; for little children quickly learn to distinguish tones of pleasure from tones of anger, etc. At three months the child makes intentional gestures in asking for or refusing a thing. "A child of seven months, who had never seen me," says M. Perez, "smiled as to an old acquaintance on hearing me pronounce his name." At nine months he would give little cries of pleasure and of appeal, some of which were evident attempts to imitate a dog, a cat, a bird. At eleven months he understood some little phrases. A child twelve months old, precocious in language, used a certain number of words in their ordinary sense. A little girl of nineteen months pronounced intelligibly many words, and passed easily from inarticulate to articulate sounds that she sought by instinct, but was aided by imitation. She ended by reproducing the last tonic syllable, of which she could modify the articulation in conformity to the law of least effort. For a long time she said only *bou* for *tambour* (drum), *fé* for *café* (coffee), *yé* for Pierre (Peter). Since then she says *a-bou* for *tambour*, *a-teau* for *gâteau* (cake). The learning of language seems in general to obey the law of least effort; it is influenced by temperament and by surroundings. The words most easily learned by children are those

which express the most salient qualities of objects, or the part which produces the principal and dominant impression. A little girl twenty months old called the decanter *vé* (*verre*, glass). A little child two years old called all dogs *wa-wa*, except his grandfather's dog, which he did not call by his own name, but only distinguished it from others. Some one made for him a little rounded figure of paper; he said *tété*, the name by which he designated the bosom of his nurse. Intelligent children often forget words that have no meaning for them; children of less intelligence, on the contrary, sometimes replace ideas by words. The mania for jabbering syllables without signification is common with children, even the most intelligent. No doubt they rest from the effort of mind that their first essays in talking cost them in making this noise, which, without requiring any exertion, charms and stuns their ears.

XVI. Notion of Self: Personality, Reflection.—The notion of self may be considered, to a certain extent, as hereditary, and already existing among the impressions of fœtal life. It is developed little by little. The personality of little children is concentrated in the sphere of emotion. They do not know distinctly either themselves or anything else, but they are sensible of the presence of objects, and they are sensible of themselves living, feeling, and acting. At three months the notion of personality is already outlived. When children begin to speak of themselves they employ the third person. M. Perez does not conclude from this that children are unable to separate their personality from external objects. The words *I*, *me*, Paul, Charles, etc., alike express the notion of personal individuality; they designate the personality of the child, a personality that he well knows. When between two and three years old the sentiment of personality is affirmed and exaggerated. A child was very delicate before the age of twenty-six months. His self-love had to be corrected. When eight years old he fell, and before getting up he walked on all-fours, making believe that he had not fallen. At another time he stumbled on the staircase, and rolled over two or three times, purposely bumping his head with a noise. He pretended to have fallen for fun. He was usually pedantic, egotistic, and conceited, but from time to time would show sympathy and diffidence.

XVII. The Moral Sense.—The child has not the absolute idea of good and bad; but he has the objective idea from the age of six or seven months. For him that which is permitted is good, that which is forbidden is bad. A child seven months old had learned from its mother, who had scolded and shaken it, that it ought not to cry to be taken up or held in arms if its wishes were not immediately granted. When ten months old the child began to get up itself in a hesitating way—a moral being. A little child of eleven months obeyed his father very well, particularly when asked to do anything for the amusement or pleasure of others. For little children, the moral law is incarnated in

their parents. A little boy, staying for two or three months with his uncle, would show how his mother managed in reference to him, and cry and gesticulate if things were not done as she did them. He would himself follow the rule of conduct that he tried to impose upon others. "It is very bad to lie," said he; "that gives mamma much pain—that makes her cry." As for the rest, the moral sense is slowly modified, according to the circumstances in which the child is placed. Both sympathy and the desire to please play an important part in the development of the moral faculties. A little girl of forty months was greatly afflicted when her mother said to her, "I am angry with baby." She was, for the most part, indifferent to her father's scoldings, whom she was accustomed to hear cry out at her, and threaten her. The young Tiedemann, when he was two years and five months old, said, when he thought he had done something good, "Everybody will say that is a good little boy." When he was naughty, if he were told, "The neighbors will see you," he ceased immediately. The moral sense is one of the faculties most susceptible of modification by education.

The love of justice sometimes manifests itself. A little boy, the first time he told a lie, was shut in the closet, and when he was set free he cried out, struck with the importance attached to his fault, "But, mamma, perhaps I am not punished enough for a fault so grave." Some children are open-handed to liberality; others, on the contrary, have the instinct of ownership strongly developed, the instinct of appropriation is also manifested, and sometimes becomes the instinct of stealing. Finally, almost all children are cruel; it is hard to prevent them from hurting animals. A little girl, two years old, very affectionate and caressing, passed three fourths of the day tormenting an old dog. The best children are betrayed into striking even those they fondly love.

Conclusion.—We find the germs of all the faculties in the little child, and sensations are the food upon which they grow. We may even say that the essential faculties are innate, since the nervous centers that manifest them are already organized at the moment of birth. The method followed by M. Perez is the scientific method; observation abounds in his work; perhaps, however, some inductions repose upon disputable interpretations. But, be this as it may, the book of M. Perez is full of interest, and can not fail to be of great utility in a study so important, so curious, and so long neglected as the psychology of infants.

THE CHEMICAL ELEMENTS.

By J. NORMAN LOCKYER, F. R. S.

I HAVE recently announced to the Royal Society that, reasoning from the phenomena presented to us in the spectroscope when known compounds are decomposed, I have obtained evidence that the so-called elementary bodies are in reality compound ones.

Although the announcement took this form, the interest taken in science nowadays by the general public is so great that it is apt to travel beyond the record; and, as able editors are not content to wait for what the experimentalist himself has to say, they are often at the mercy of those who, perhaps more from misapprehension than anything else, are prepared to provide columns filled with statements wide of the mark. Nor is this all. If there be a practical side to the work, some "application of science" is brought to the front, and the worker's own view of his labor is twisted out of all truth.

This has happened in my case. The idea of simplifying the elements is connected with the philosopher's stone. The use of the philosopher's stone was to transmute metals; therefore I have been supposed to be "transmuting" metals; and imaginations have been so active in this direction that I am not sure that, when my paper was eventually read at the Royal Society, many were not disappointed that I did not incontinently then and there "transmute" a ton of lead into a ton of gold.

It is in consequence of this general misapprehension of the nature of my work, that I the more willingly meet the wishes of the editor that I should say something about it. The paper itself I need not reproduce, as it has appeared *in extenso* elsewhere[1]; but there are many points touching both the origin of the views I have advanced and the work which has led up to them, on which I am glad of the opportunity of addressing a wider public.

It is now upward of ten years since I began a series of observations having for their object the determination of the chemical constitution of the atmosphere of the sun. The work done, so far as the number of elementary substances found to exist in it, I summed up in a former article[2]; but the ten years' work had opened up a great number of problems above and beyond the question of the number of elements which exist in the solar atmosphere, because we were dealing with elements under conditions which it is impossible to represent and experiment on here.

In the first place, the temperature of the sun is beyond all definition; secondly, the vapors are not confined; and, thirdly, there is an enor-

[1] "American Journal of Science and Arts."

[2] Printed in the "Popular Science Monthly Supplement" for August, 1878.

mous number of them all mixed together, and free, as it were, to find their own level. Nor is this all. Astronomers have not only determined that the sun is a star, and have approximately fixed his place in nature as regards size and brilliancy, but they have compared the spectrum of this star, this sun of ours, with those of the other bodies which people space, and have thus begun to lay the foundations of a science which we may christen Comparative Stellar Chemistry. Dealing with the knowledge already acquired along this line, we may say roughly that there are four kinds of stars recognizable by their spectra.

We have first the brightest and presumably hottest stars, and of these the spectrum is marvelously simple—so simple, in fact, that we say their atmospheres consist in the main of only two substances—a statement founded on the observation that the lines in the spectra are matched by lines which we see in the spectra of hydrogen and calcium; there are traces of magnesium, and perhaps of sodium too, but the faintness of the indication of these two latter substances only intensifies the unmistakable development of the phenomena by which the existence of the former is indicated.

So much, then, for the first class; now for the second. In this we find our sun. In the spectra of stars of this class, the indications of hydrogen are distinctly enfeebled, the evidences by which the existence of calcium has been traced in stars of the first class are increased in intensity, and, accompanying these changes, we find all simplicity vanished from the spectrum. The sodium and magnesium indications have increased, and a spectrum in which the lines obviously visible may be counted on the fingers is replaced by one of terrific complexity.

The complexity which we meet with in passing from the first class to the second is one brought about by the addition of the lines produced by bodies of chemical substances of moderate atomic weight. The additional complexity observed when we pass from the second stage to the third is brought about by the addition of lines due in the main to bodies of higher atomic weight. And—this is a point of the highest importance—at the third stage the hydrogen, which existed in such abundance in stars of the first class, has now entirely disappeared.

In the last class of stars to which I have referred, the fourth, the lines have given place to fluted bands, at the same time that the light and color of the star indicate that we have almost reached the stage of extinction. These facts have long been familiar to students of solar and stellar physics. Indeed, in a letter written to M. Dumas, December 3, 1873, and printed in the "Comptes Rendus," I thus summarized a memoir which has since appeared in the "Philosophical Transactions":

Il semble que plus une étoile est chaude, plus son spectre est simple, et que les éléments métalliques se font voir dans l'ordre de leurs poids atomiques.[1]

Ainsi nous avons:

[1] The old system of atomic weights was the one referred to.

1. Des étoiles très-brillantes où nous ne voyons que l'hydrogène *en quantité énorme*, et le magnésium ;

2. Des étoiles plus froides, comme notre soleil, où nous trouvons :

| Hydrogène + Magnésium + Sodium
| Hydrogène + Magnésium + Sodium + Calcium + Fer, . . . ;

dans ces étoiles, pas de métalloïdes ;

3. Des étoiles plus froides encore, dans lesquelles *tous les éléments métalliques sont* associés, où leurs lignes ne sont plus visibles, et où nous n'avons que les spectres des métalloïdes et des composés.

4. Plus une étoile est âgée, *plus l'hydrogène libre disparaît ;* sur la terre, nous ne trouvons plus d'hydrogène en liberté.

Il me semble que ces faits sont les preuves de plusieurs idées émises par vous. J'ai pensé que nous pouvions imaginer une "*dissociation céleste*," qui continue le travail de nos fourneaux, et que le métalloïdes sont des composés qui sont dissociés par la température solaire, pendant que les éléments métalliques monatomiques, dont les poids atomiques sont les moindres, sont précisément ceux qui résistent même à la température des étoiles les plus chaudes.

Before I proceed further I should state that, while observations of the sun have since shown that calcium should be introduced between hydrogen and magnesium for that luminary, Dr. Huggins's photographs have demonstrated the same fact for the stars, so that in the present state of our knowledge, independent of all hypotheses, the facts may be represented as follows :

Hottest Stars .
Sun . . } Lines[1] of { H+Ca+Mg
Cooler Stars . } { H+Ca+Mg+Na+Fe
{ — — Mg+Na+Fe+Bi+Hg

Coolest . Fluted bands of — — — — — — { Fluted Spectra of Metals and Metalloids.

I have no hesitation in stating my opinion that in this line of facts we have the most important outcome of solar work during the last ten years ; and if there were none others in support of them, the conclusion would still stare us in the face that *the running down of temperature in a mass of matter which is eventually to form a star is accompanied by a gradually increasing complexity of chemical forms.*

This, then, is the result of one branch of the inquiry, which has consisted in a careful chronicling of the spectroscopic phenomena presented to our study by the various stars.

Experimentalists have observed the spectrum of hydrogen, of calcium, etc., in their laboratories, and have compared the bright lines visible in the spectra with the dark ones in the stars, and on this ground they have announced the discovery of calcium in the sun or of hydrogen in Sirius.

[1] Symbols are used here to save space. H = Hydrogen, Ca = Calcium, Mg = Magnesium, Na = Sodium, Fe = Iron, Bi = Bismuth, Hg = Mercury.

In all this work they have taken for granted that in the spectrum thus produced in their laboratories, they have been dealing with the vibration of one unique thing, call it atom, molecule, or what you will; that one unique thing has by its vibrations produced all the lines visible, which they have persistently seen and mapped in each instance.

It is at this point that my recent work comes in, and raises the question whether what has been thus taken for granted is really true. And now that the question is raised, the striking thing about it is that it was not asked long ago.

One reason is this: Time out of mind—or, rather, ever since Nicolas Le Fèvre, who was sent over here by the French King at the request of our English one at the time the Royal Society was established, pointed out that chemistry was the art of *separations* as well as of *transmutations*—it has been recognized that, with every increase of temperature, or dissociating power, bodies were separated from each other. In this way Priestley, from his "plomb rouge," separated oxygen, and Davy separated potassium; and as a final result of the labor of generations of chemists, the millionfold chemical complexity of natural bodies in the three kingdoms of nature has been reduced by separations till only some seventy so-called elements are left.

Now this magnificent simplification has been brought about by the employment of moderate temperatures—moderate, that is to say, in comparison with the transcendental dissociating energies of electricity as employed in our modern voltaic arcs and electric sparks.

But, in the observations made during the last thirty years on the spectra of bodies rendered incandescent by electricity, *we have actually, though yet scarcely consciously, been employing these transcendental temperatures*, and, if it be that this higher grade of heat does what all other lower grades have done, then the spectrum we have observed in each case is not the record of the vibrations of the particular substance with which we have imagined ourselves to be working only, but of all the simpler substances produced by the series, whether short or long, of the "separations" effected.

The question, then, it will be seen, is an appeal to the law of continuity, nothing more and nothing less. Is a temperature higher than any yet applied to act in the same way as each higher temperature, which has been applied, has done? Or is there to be some unexplained break in the uniformity of nature's processes?

The definite reason for my asking the question at the present time has been this: The final reduction of four years' work at a special branch of the subject to which I will refer presently, on the assumption that at the temperature of the electric arc we do not get such "simplifications," has landed me in the most helpless confusion, and, if I do not succeed in finding a higher law than that on which I have been working, my four years' work, in this direction at all events, will have been thrown away.

This and other reasons compel me to hold that the answer to the question put is, that what has been taken for granted is, in all probability, *not* true. But before I proceed to give the reasons for the faith that is in me I must, at the risk of being both technical and tedious when I should wish to be neither, lead up to the understanding of them.

The spectroscope, however simple or complex it may be, is an instrument which allows us to observe the image of the slit through which the light enters it, in the most perfect manner. If the light contains rays of every wave-length, then the images formed by each will be so close together that the spectrum will be continuous, that is, without break. If the light contains only certain wave-lengths, then we shall get certain, and not all, of the possible images of the slit, and the spectrum will be discontinuous.

Again, if we have an extremely complex light-source, let us say a solid and a mixture of gases giving us light, and we allow the light to enter, so to speak, indiscriminately into the spectroscope, then in each part of the spectrum we shall get a summation—a complex record—of the light of the same wave-length proceeding from all the different light-waves. But if by means of a lens we form an image of the light-source, so that each particular part shall be impressed in its proper place on the slit-plate, then in the spectrum the different kinds of light will be sorted out.

There is a simple experiment which shows clearly the different results obtained. If we observe the light of a candle with the spectroscope in the ordinary manner, that is, by placing the candle in front of the slit at some little distance from it, we see a band of color—a continuous spectrum—and in one particular part of the band we see a yellow line, and occasionally in the green and in the blue parts of the band other lines are observable. Now, if we throw an image of the candle on to the slit—the slit being horizontal and the image of the candle vertical—we then get three perfectly distinct spectra. We find that the interior of the candle, that is the blue part (best observed at the bottom of the candle), gives us one spectrum, the white part gives us another, while on the outside of the candle, so faint as to be almost invisible to the eye, there is a region which gives us a perfectly distinct spectrum with a line in the yellow. In this way there is no difficulty whatever in determining the coexistence of three light-sources, each with its proper spectrum, in the light of a common candle.

We see in a moment that much the same condition of affairs will be brought about if, instead of using a candle, we use an electric arc, in which the pure vapor of the substance which is being rendered incandescent fills the whole interval between the poles, the number of particles and degree of incandescence being smaller at the *sides* of the arc. We can throw an image of such an *horizontal* arc on a vertical slit; the slit will give then the spectrum of a section of the arc at right angles to its length. The vapor which exists farthest from the core of the arc has a

much more simple spectrum than that of the core of the arc itself. The spectrum of the core consists of a large number of lines, all of which die out until the part of it farthest from the center gives but one line.

In this way the spectrum of each substance furnishes us with *long* and *short* lines, the long lines being common to the more and less intensely heated parts of the arc, and the short lines special to the more heated one. This is the first step.

It has been necessary to enter thus at length into the origin of the terms long and short lines, because almost all the subsequent work which need be referred to now has had for its object the investigation of the phenomena presented by them under different conditions. The first results obtained were as follows :

1. When a metallic vapor was subjected to admixture with another gas or vapor, or to reduced pressure, I found that its spectrum became simplified by the abstraction of the shortest lines and by the thinning of many of the remaining ones. To obtain reduction of pressure, the metals were inclosed in tubes in which a partial vacuum was produced. *In all these experiments it was found that the longest lines invariably remained visible longest.*[1]

2. When we use metals chemically combined with a metalloid—in other words, when we pass from a metal to one of its *salts* (I used chlorine)—only the longest lines of the metal remain. The number is large in the case of elements of low atomic weight, and small in the case of elements of high atomic weight, and of twice the atom-fixing power of hydrogen.

3. When we use metals mechanically mixed, only the longest lines of the smallest constituent remain. On this point I must enlarge somewhat by referring to a series of experiments recorded in the "Philosophical Transactions" (1873).

A quantity of the larger constituent, generally from five to ten grammes, was weighed out, the weighing being accurate to the fraction of a milligramme; and the requisite quantity of the smaller constituent

[1] In the case of zinc the effect of these circumstances was very marked, and they may be given as a sample of the phenomena generally observed. When the pressure-gauge connected with a Sprengel pump stood at from 35 to 40 millimetres, the spectrum at the part observed was normal, except that the two lines 4924 and 4911 (both of which, when the spectrum is observed under the normal pressure, are lines with thick wings) were considerably reduced in width. On the pump being started these lines rapidly decreased in length, as did the line at 4679—4810 and 4721 being almost unaffected; at last the two at 4924 and 4911 vanished, as did 4679, and appeared only at intervals as spots on the poles, the two 4810 and 4721 remaining little changed in length, though much in brilliancy. This experiment was repeated four times, and on each occasion the gauge was found to be almost at the same point, viz.:

1st observation, when the lines 4924 and 4911 were gone, the gauge stood at 30 millimetres.						
2d	"	"	"	"	29	"
3d	"	"	"	"	29	"
4th	"	"	"	"	31	"

was calculated to give, when combined, a mixture of a definite percentage composition by weight (this being more easily obtainable than a percentage composition by volume).

The quantities generally chosen were 10, 5, 1, and 0·1 per cent.

In a few cases, with metals known to have very delicate spectral reactions, a mixture of 0·01 per cent. was prepared.

Observations were then made of the spectrum of each specimen, and the result was recorded in maps in the following manner: First, the pure spectrum of the smallest constituent was observed, and the lines laid down from Thalén's map.

The series thus mapped was as follows:

Tin + Cadmium,	percentages of Cd	10, 5, 1,	0·15
Lead + Zinc,	"	Zn 10, 5, 1,	0·1
Lead + Magnesium,	"	Mg 10, 1, 0·1,	0·01

The observations showed that the lines of the smallest constituent disappeared as the quantity got less. Although we had here the germs of a quantitative spectrum analysis, the germs only were present, because from the existence of several "critical points," and great variations due to other causes, the results obtained were not constant.

In a subsequent research on the gold-copper alloys used in the coinage, Mr. Roberts, the Chemist of the Mint, and myself were able to show that the shortening in the length of the lines by reduced quantity was such a definite physical effect following upon reduced quantity, that a difference of $\frac{1}{10000}$ part of copper in gold could be detected.

We are now in possession of the facts utilized in the work which has led up to the subject discussed in the present paper.

They have been utilized along two perfectly distinct lines of thought:

(1) They have been used in an attempt to enable us to produce a spectrum of a substance free from lines due to the impurities which are almost always present.

(2) They have been used to indicate the existence and amount of dissociation when acknowledged compounds have been submitted to the action of different and increasing temperatures.

I will deal with (1) first.

The elimination of impurity lines is conducted as follows: The spectrum of the element is first confronted with the spectra of the substances most likely to be present to impurities. This is most conveniently done by photographing the spectra on the same plate one above the other, so that common lines are continuous.

The retention or rejection of lines coincident in two or more spectra is determined by observing in which spectrum the line is thickest; where several elements are mapped at once, all their spectra are confronted on the same plate, as by this means the presence of one of the substances as an impurity in the others can be at once detected.

Lines due to impurities, if any are thus traced, are marked for omission from the map and their true sources recorded, while any line that is observed to vary in length and thickness in the various photographs is at once suspected to be an impurity line, and if traced to such is likewise marked for omission. I give a case.

The two lines H and K (3933 and 3968), assigned both to iron and calcium by Ångström, are proved to belong to calcium in the following way :

a. The lines are well represented in the spectrum of commercial wrought iron, but are absolutely coincident with two thick lines in the spectrum of calcium chloride with which the iron spectrum was confronted.

b. The lines are represented by mere traces in the spectrum of a specimen of pure iron prepared by the late Dr. Matthiessen. Both poles of the lamp were of iron, the lower pole consisting of an ingot of the metal which had been cast in a lime-mold.

c. The lines are altogether absent in a photograph of pure iron, where both poles of the lamp were of the pure metal *not* cast in lime, and they are likewise absent in a photograph of the spectrum of the Lenarto meteorite.

By eliminating lines due to impurities in the manner just described, a spectrum is at length obtained, of which every line is assignable to the particular element photographed, the same temperature being employed in the case of all the elements observed.

With regard to the second line of work, I should commence by stating that from a beautiful series of researches carried on by several methods, Mitscherlich concluded in 1864 *that every compound of the first order, heated to a temperature adequate for the production of light, is not decomposed, but exhibits a spectrum peculiar to this compound.*

In some experiments of my own, communicated to the Royal Society in 1873, I observed :

First. That whether the spectra of iodides, bromides, etc., be observed in the flame or a weak spark, *only the longest lines of the metals are visible*, showing that only a small quantity of the simple metal is present as a result of partial dissociation, and that by increasing the temperature, and consequently the amount of dissociation, *the other lines of the metal appear in the order of their length with each rise of temperature.*

Secondly. I convinced myself that while *in air*, after the first application of heat, *the spectra and metallic lines are in the main the same, in hydrogen the spectra are different for each compound, and true metallic lines are represented according to the volatility of the compound, only the very longest lines being visible in the spectrum of the least volatile compound.*

Thirdly. I found that with a considerable elevation of temperature *the spectrum of the compound faded almost into invisibility.*

These results enable us to make the following statement:

A compound body, such as a salt of calcium, has as definite a spectrum as that given by the so-called elements; but while the spectrum of the metallic element itself consists of lines, the number and thickness of some of which increase with increased quantity, the spectrum of the compound consists in the main of channeled spaces and bands, which increase in like manner.

In short, the molecules of a simple body and a compound one are affected in the same manner by quantity in so far as their spectra are concerned; *in other words, both spectra have their long and short lines*, the lines in the spectrum of the element being represented by bands or fluted lines in the spectrum of the compound; and in each case the greatest simplicity of the spectrum depends upon the smallest quantity, and the greatest complexity upon the greatest.

The heat required to act upon such a compound as a salt of calcium, so as to render its spectrum visible, dissociates the compound according to its volatility; the number of true metallic lines which thus appear is a measure of the quantity of the metal resulting from the dissociation, and as the metal lines increase in number, the compound bands thin out.

These results bring us face to face with the subject-matter of the recent work.

First with regard to impurity elimination. I find that, although the method is good for detecting and eliminating impurities, there are still short-line coincidences between metals which are pure.

This "higher law" has come out in the following manner:

For the last four years I have been engaged upon the preparation of a map of the solar spectrum on a large scale, the work including a comparison of the Fraunhofer lines with those visible in the spectrum of the vapor of each of the metallic elements in the electric arc.

To give an idea of the thoroughness of the work, at all events in intention, I may state that the complete spectrum of the sun, on the scale of the working map, will be half a furlong long; that to map the metallic lines and purify the spectra in the manner described, more than 100,000 observations have been made and about 2,000 photographs taken.

In some of these photographs we have vapors compared with the sun; in others vapors compared with each other; and others again have been taken to show which lines are long and which are short in the spectra.

A rigorous application of the system of impurity elimination formed, of course, a large part of the work.

The final reduction of the photographs of all the metallic elements in the region 39–40—a reduction I began in the early part of last year—summarized all the observations of metallic spectra compared with the Fraunhofer lines accumulated during the whole period of observation, and all the results of the impurity elimination.

Now this reduction has shown me that the hypothesis that identical lines in different spectra are due to impurities is not sufficient. I show in detail in the paper the hopeless confusion in which I have been landed.

I find short-line coincidences between many metals the impurities of which have been eliminated, or in which the freedom from mutual impurity has been demonstrated by the absence of the longest lines.

The explanation of this result on the hypothesis that the elements are elementary does not lie on the surface, but it does on the assumption that they are compounds and behave like them.

This is the first point. We now pass from the results brought about *at the same temperature with different substances* to those observed *at different temperatures with the same substance.*

I find that when *the temperature is greatly varied*, the elements behave spectroscopically exactly as compound bodies do, as we have already seen. New lines are developed with increasing temperatures, and others fade in precisely the same way as the metallic lines made their appearance in the salts at the expense of the latter, which faded too.

In short, the observations and reasoning which I formerly employed to show how acknowledged compounds behaved in the spectroscope are now seen to indicate the compound nature of the chemical elements themselves.

In a paper communicated to the Royal Society in 1874, referring, among other matters, to the reversal of some lines in the solar spectrum, I remarked :

> It is obvious that greater attention will have to be given to the precise *character* as well as to the position of each of the Fraunhofer lines, in the thickness of which I have already observed several anomalies. I may refer more particularly at present to the two H lines 3933 and 3968 belonging to calcium, which are much thicker in all photographs of the solar spectrum (I might have added that they were by far the thickest lines in the solar spectrum) than the largest calcium line of this region (4226·3), this latter being invariably thicker than the H lines in all photographs of the calcium spectrum, and remaining, moreover, visible in the spectrum of substances containing calcium in such small quantities as not to show any traces of the H lines.
>
> How far this and similar variations between photographic records and the solar spectrum are due to causes incident to the photographic record itself, *or to variations in the intensities of the various molecular vibrations under solar and terrestrial conditions*, are questions which up to the present time I have been unable to discuss.

The progress of the work has shown that the differences here indicated are not exceptions, but are truly typical when the minute anatomy of the solar spectrum is studied.

Kirchhoff, indeed, as early as 1869 seems to have got a glimpse of the same thing, for in his memorable paper, which may justly be re-

garded as the basis of all subsequent work, he is careful to state that the sixty iron lines in the sun, to which he referred, only agree "*as a rule*" in intensity with those observed in the electric spark. Those who have given an account of his work have not always been so cautious. Indeed, I find Professor Roscoe[1] running far beyond the record in the following sentence:

> In order to map and determine the positions of the bright lines found in the electric spectra of the various metals, Kirchhoff, as I have already stated, employed the dark lines in the solar spectrum as his guides. Judge of his astonishment when he observed that dark solar lines occur in positions connected with those of all the bright iron lines! Exactly as the sodium lines were identical with Fraunhofer's lines, so for each of the iron lines, of which Kirchhoff and Ångström have mapped no less than 460, a dark solar line was seen to correspond. Not only had each line its dark representative in the solar spectrum, *but the breadth and degree of shade of the two sets of lines were seen to agree in the most perfect manner, the brightest iron lines corresponding to the darkest solar lines.*

This statement was made to prove the absolutely identical nature of the iron vapor in the sun's atmosphere and in the electric spark. As the statement is not true, the vapors can hardly be identical.

Such, then, is the reasoning on which I base the two counts in the indictment against the simple nature of the elementary bodies.

First, the common lines visible in the spectra of different elements at high identical temperatures point to a common origin. Secondly, the different lines visible in the spectra of the same substance at high and low temperatures indicate that at high temperatures dissociation goes on as continuously as it is generally recognized to do at all lower temperatures.

In my paper I attempt to show that if we grant that the highest temperatures produce common bases—in other words, if the elements are really compounds—all the phenomena so difficult to account for on the received hypothesis find a simple and sufficient explanation. And, with regard to the second count, I discuss the cases of calcium, iron, lithium, and hydrogen. I might have brought, and shall subsequently bring, other cases forward. In all these I show that the lines most strongly developed at the highest temperatures are precisely those which are seen almost alone in the spectra of the hottest stars, and which are most obviously present in the spectrum of our own sun. Now, if it be true that the temperature of the arc breaks up the elements, then the higher temperature of the sun should do this in a still more effective manner. Here, then, we have a test.

I have put this question to the sun, and I have sent in a second paper to the Royal Society embodying a preliminary discussion of Professor Young's work at Sherman, Tacchini's observations, and my own. In this paper I state my grounds for the belief that all the solar phe-

[1] "Spectrum Analysis," third edition, p. 240.

nomena we have been watching with our spectroscopes for the last ten years can not be explained on the existing hypothesis, and that they are simply and sufficiently accounted for by supposing that primordial atoms are associated in the corona and dissociated in the reversing layer.

In this way the vertical currents in the solar atmosphere, both ascending and descending, the intense absorption in sun-spots, their association with the faculæ, and *the apparently continuous spectrum of the corona*, and its structure, find an easy solution.

We are yet as far as ever from a demonstration of the cause of the variation in the temperature of the sun; but the excess of so-called calcium with minimum sun-spots, and excess of so-called hydrogen with maximum sun-spots, follow naturally from the hypothesis, and afford indications that the temperature of the hottest region in the sun closely approximates to that of the reversing layer in stars of the type of Sirius and *a* Lyræ.

EXPERIMENTS WITH LIVING HUMAN BEINGS.[1]

By GEORGE M. BEARD, M. D.

I.

MR. JOHN STUART MILL, in the preface to his work on "Logic and the Principles of Evidence," observes that while in the search for truth we may be able, in some cases, to avoid errors instinctively and successfully, although unable to formulate the method by which we do so, yet it is an advantage not to be dispensed with to have a rational understanding of the philosophy of reasoning, so that we shall not be forced to depend alone on blind and irregular instinct.

In experimenting with *living* human beings there are *six* sources of errors which instinctively physiologists and physicians sometimes guard against and allow for, but which ought to be and can be, as I contend, and shall here aim to prove, reduced to a positive science. As these elements of error come in the main from the nervous system, their study belongs preëminently to neurology, or the study of the nervous system in health and disease; and it is because of the backwardness of this specialty that the subject has been thus far passed by.

The deficiencies of our knowledge of this subject were forced on

[1] An abstract of a portion of this paper was read before the American Neurological Association at New York, June, 1878. This essay relates to questions suggested in my series of papers on "The Scientific Study of Human Testimony," published in the May, June, and July (1878) numbers of the "Monthly," and may be of service to those who are interested in that subject. This department of science is of especial interest at the present time, when the experiments of Charcot and the criticisms upon them are exciting so much attention.

my attention several years ago, when I was engaged in the study of the physiology of mind-reading, and making experiments in mental therapeutics; and in essays published on those topics I briefly noted these errors, which I was obliged to study out, and without any theoretical guide or precedent. I found that the whole matter—the importance and interest of which were of the very highest, practically as well as scientifically—was as unexplored as central Africa, and that it was necessary to hew one's way clear of infinite obstructions at every step.

From the elevation of this subject to a positive science these two practical benefits must flow:

1. The world will be spared the reports of such experiments as those of the physician who examined into the condition of the hysterical girls that were the cause of the Salem witchcraft epidemic, and of the committees of the French Academy, of Gregory and of Elliotson and others, with clairvoyance and mesmeric trance; of Crookes with Home, of Wallace and Zöllner with Slade, and, latest of all, of Parkhurst and others with Mollie Fancher; of Charcot, Westphal, and their coadjutors with metalloscopy and metal-therapeutics; and will at the same time be able to reach the solid truth that lies behind all such accredited phenomena. These experiments and these reports are often made by strong and earnest men; indeed, the abler the experimenter in the present state of the subject, the worse his experiments and his reports of these experiments: instead of arriving at the truth of many questions of physiology, we get farther and farther from it the more we study them.

2. There will be more precision to all our investigations in regard to the action of remedies, and especially of new remedies. At the present time we know not whether to believe or reject any report of the virtues of any new medicine or mode of treatment, however high the authority for the reports, for we feel instinctively the elements of error which those who introduce new remedies and modes of treatment ought to know, and in time will know and rationally provide for.

3. Men of narrow or but limited ability will be able to attain accurate results in experimenting with living human beings where now the strongest scientific geniuses of the world are every day failing abjectly and humiliatingly. Sir William Hamilton, in his work on "Logic," remarks most truly that the proud boast of Bacon that, by the system of inductive philosophy, it would be possible for ordinary men to make discoveries in science, has been strictly fulfilled: every day under the light of the inductive method very commonplace minds are finding new and important facts that go to swell the current of science. Genius of the first order is rare, and in every field of knowledge the details of cultivation must be worked out by the average man; the bulk of the work is done, always has been done, and probably always will be done, by talent rather than by genius.

The elements of error in experimenting with *inanimate* objects were indicated, in a general way, by Bacon, under the strange headings "Idols of the Tribe," "Of the Den," "Of the Forum," "Of the Theatre"; and later writers on evidence and the principles of science have repeated or assumed the Baconian formulas; but the special elements of error in experimenting with *living* human beings have escaped conscious and exhaustive analysis. To have formulated these elements of error much sooner than the present time would have been quite impossible, for our knowledge of the involuntary life—one of the most important factors—was far too limited.

The science and art of experimenting with living human beings is indeed now in precisely the same state as the general philosophy of induction prior to the time of Bacon. Before the era of the Baconian philosophy, indeed in all eras, men had *instinctively* employed the inductive method, but the principles of that method had never been formulated; consequently, when philosophers reasoned or attempted to reason on the subject, they almost always went wrong. The philosophy of Bacon applies only to *inanimate* nature; of the art of seeking truth through experiments on *living* human beings—of the *six* sources of error in all such experiments and the means of guarding against them—he knew nothing, and evidently suspected nothing; and that branch of philosophy—of such vast import in biological investigations—has remained to this day unstudied and almost unthought of; hence, although some experimenters are saved through their instincts, others—and those the very ablest scientific geniuses of the age—never attempt to reason on the subject without falling into serious error.

In experimenting with living human beings there are, as above stated, just *six* sources of error, all of which are to be recognized and systematically and, if possible, also simultaneously guarded against if our results are to command the confidence and homage of science. To be guilty of overlooking, in any research, even one of these six possibilities of error, is to be guilty of overlooking all, and practically to vitiate all the results of our labors.

These six sources of error are as follows:

First Source of Error: *The phenomena of the involuntary life in both the experimenter and the subject experimented on.*—Under this head are embraced trance, with all its manifold symptoms, and all the interactions of mind and body that are below the plane of volition or of consciousness or of both. Without a knowledge of this side of physiology, scientific experimenting with living human beings is impossible. It is a want of this knowledge that makes most of the experiments of scientific men in this department during the past century so unsatisfactory and so ludicrous.

Second Source of Error: *Unconscious deception on the part of the subject experimented on.*—This unconscious deception comes

through the involuntary life—the mind of the subject acting on the body—and producing results which, it is to be noted, are as decided, as uniform, and as permanent as when produced by powerful objective influences. This element of error slips into all the ordinary experiments with new remedies and supposed new forces in the animal body, thus corrupting science at its very sources. The neglect of this element of error would of itself, even though all the other errors were guarded against, destroy entirely the scientific value of all such experiments, for example, as those of the committees of the French Academy with clairvoyants and mesmerism; it is because physicians of experience instinctively feel this element of error, that reports of cases wrought by novel and strange and especially by imposing methods of treatment are so frequently discredited. Under this head come also all the so-styled miracles of healing, whatever may be the paraphernalia through which they are accomplished.

I know not where can be found a better single illustration of the effect of this element of error, alone of itself, in scientific research, when all the other elements of error seem to be provided for, than in the experiments on animal magnetism of the late Dr. J. K. Mitchell, as recorded in the volume of his miscellaneous writings. Dr. Mitchell was an original thinker, an observer of patience and care, and a clear and logical writer, who suggested more than he told, and his chapter on animal magnetism was incomparably the best essay ever written on that subject down to the date of its publication. This paper—which consisted of a record of independent, careful, and many times repeated experiments on living human beings, with remarks thereon—shows that the author not only had the courage and the power to do his own thinking and experimenting, but that he recognized some of the chances of error in experiments of this kind, and fortified himself against them; while of the errors that enter through the doors of the involuntary life—the unconscious deception of the subject experimented on—he knew, and apparently suspected, little. His essay is therefore at once a model and a warning: a model for thoroughness and precision up to a certain point, or within a limited area; a warning as demonstrating the worthlessness of all experiments with human beings when any one or two of the six sources of mistake are overlooked. So accurate and scientific were these experiments, in certain directions, that they have furnished an important contribution to our knowledge of some of the symptoms of mesmerism, in spite of the fact that the author failed, like hundreds of able men in science before him, to solve the problem of the nature of trance. By not understanding and taking into account the phenomena of the involuntary life, of which in his day very little was known, and of trance, of which nothing was known, this acute and philosophic observer allowed the subjects on whom he operated to constantly deceive themselves and deceive him, and to drive him to the logical but absolutely false conclusion that the mesmeric trance was an

objective state induced by a supposed fluid, or force, or influence, then and now known as animal magnetism.

In order to be able always to guard effectively and absolutely against these two sources of error that I have thus far specified, just two things are necessary for the experimenter:

1. A general knowledge of the phenomena of the involuntary life, including both the action of mind on body and of body on mind, in health and in disease, and especially of the real nature and philosophy of trance, the state in which the involuntary life culminates.

2. The subject experimented on must always be *deceived* in the experiments in such a way that this involuntary action of his mind or body can not come in and destroy the experiment. The subject may be successfully deceived in three different ways, which I shall presently specify.

Burq, Charcot, Westphal, and their coadjutors in the now well-known metalloscopy experiments, failed on both of these points. Many of the critics of those experiments, as Althaus, Reynolds, and other physicians in England, also failed to comprehend these points, hence the inconsistency and unsatisfactoriness of the discussions to which these experiments gave rise. The claim of Burq and Charcot and Westphal in regard to the temporary relief of hysterical and sometimes of organic anæsthesia by the local application of metals might be entirely true, but thus far they have failed, in a scientific sense, to prove it to be true. I do not deny their results—indeed, there is a possibility that some of them may be genuine—although in my own experience with the same method I fail to confirm their claims; it is in the manner in which the experiments were conducted, without regard to the results, that the non-expertness of these experimenters appeared. The criticism I have to make on Charcot is that, in his elaborate lectures on this subject, he nowhere gives evidence of a full appreciation of the power of the involuntary life, particularly in hysterical conditions, or of the true and only method of systematically and successfully guarding against it. The experiments now going on under the same superintendence in the hospital of Salpêtrière with mesmeric trance, and with the effects of magnets and lights on catalepsy and kindred conditions, are all open to the same criticism.

If some savage fresh from the jungles were put on board of an engine, and told how to open the valves, he might very naturally infer that his own feeble strength caused the train to move; in like manner, scientific experimenters with living human beings attribute the phenomena that follow the application of metals and magnets and passes and flummeries solely to the objective influence of these appliances, whereas in truth these and similar performances but serve to let on the potent forces of the subject's own mind. The mistake of these philosophers is indeed quite analogous to that of the little boy who,

when placed on the front seat of the carriage, pleases himself with the fancy that he is guiding the horse, when all the time his strong father behind him is quietly holding and pulling the reins. In all experiments with living human beings, as in the special branch that we call therapeutics, it is oftentimes not what we do, but *how* we do it, that determines the results.

As regards this first point—the action of mind on body—I may say that, by a series of experiments not yet published, but a brief abstract of which has been twice presented to this Association, it has been proved that, by properly turning the mind of the patient on his body, through excitations of the emotions of wonder and special expectation, it is possible not only to relieve for the time various functional diseases, but in many instances to *perfectly* and *permanently cure* them; and it was also shown that *organic* or *structural* diseases may be relieved in the same way, in some cases, more satisfactorily than by any objective medical treatment whatever. The method by which the emotions are to be acted upon for the purposes of mental therapeutics are now so far organized into a science that any one who will make himself practically familiar with the subject can obtain the same results. The first mistake of Charcot and his coadjutors in France, and his followers in England and in Germany, was in assuming that such effects as the orderly, uniform reappearance of the sense of the different colors in hysterical women, and the symmetrical transference of sensory phenomena from one side of the body to the other, under the local application of metallic disks in hemianæsthesia, could not be produced *subjectively* by the mind of the patient. Such an assumption would never have been made by any one who had performed or witnessed the experiments in mental therapeutics of which I have spoken; for, again and again, not only in hysteria, but in other forms of disease, and in conditions not distinctively nervous, I have obtained results which, in definiteness, in quantity, and in permanence, are far more imposing, proving beyond question that, when all the sources of error were considered and provided for, the results were entirely independent of any objective power in the means employed—were, in short, subjective purely; applications of metals, or wood, or paper, or no applications at all, provided the subject expected them, being equally effective.

Science is not a matter of opinion; its very essence is demonstration; and the question whether, in any given experiments, the results are subjective or objective, can be brought entirely out of all discussion and all opinion, provided the elements of error are understood and avoided. Indeed, all discussion in scientific matters must be, in logical strictness, unscientific: if we know anything, there may be need for statement, of explanation, of illustration, but none for discussion; if we do not know, the course of wisdom is to keep silence until we do. With the formulated six sources of error before them, and the methods of protecting themselves against them, the experiments of Charcot

would never have been discussed, even for a moment, in any scientific body.

The *three* methods of deceiving the subject by which alone the element of error from mind acting on body can be eliminated, and the results of experiments with living human beings transferred from the realm of opinion to science or positive knowledge, are these:

1. By doing something when the subject experimented on believes that we are doing nothing.

2. By doing nothing when the subject believes that we are doing something.

3. By doing something different from what the subject believes is being done.

In experiments of importance, as where radical and overwhelming discoveries in science are claimed to be made, *all* of these methods of deceiving should be used; and it is because they are not used in the experiments of scientific men that we are constantly compelled to face and listen to the claims of "animal magnetism," of "odic force," of "spiritism," of "cundurango," of "blue glass," and, during the past year, of "Mollie Fancher," of "metalloscopy," and "metal-therapeutics."

A classical example of one method of deception in experiments of this character was afforded by the *exposé* of the performances of mesmerized or professedly mesmerized girls by Mr. Wakley, of the London "Lancet." A good example of neglect of this deception, as well as of ignorance of the relation of mind to body, is found in the experiments of Dr. Vansant with magnets, as published by him a few years ago. This writer gives an immense number of differential symptoms that, as he claims, are produced by the north and south poles of the magnet; his experiments were in the same line with the famous Perkins tractors, though apparently more scientific; the same criticism applies to the researches that are now being made in the Salpêtrière Hospital in Paris, where, according to the testimony of experts who have witnessed them, and the statements of the experimenters themselves, no systematic deception is employed or even suggested.

That even the strongest leaders in physiology are not fully armed against the errors that beset experimental research, when living human beings are the subjects, is shown in the not long ago published Lowell Lectures of Professor Brown-Séquard, wherein that master in experimental study through the processes of vivisection declares that the claims of telling of time through the back of the head are authentic. Deductive reasoning for ever disproves this claim, which any inductive research, properly conducted, must always confirm; but any test to be of value must, at every step, shut out absolutely all the six avenues of error; and the report of any test, in order to be worth reading, must clearly state and show that all such errors were so excluded.

Experiments in physics are likewise, in some instances, complicated with experiments with living human beings. Thus in the "Keely motor" and "Winter motor" claims, and in other like devices for the overthrow of the law of the conservation of energy, the apparatus for generating power was in the hands of interested non-experts, who might be capable of either willful or self-deception—for the purposes of science it matters not which—and no satisfactory experiment could be made unless these possibilities of error could be eliminated.

The temporary success of cundurango was almost entirely the result of self-deception of those who, under the mingled emotions of hope, despair, and expectation, availed themselves of it. It is impossible to introduce any drug or system of treatment for cancer, or any other grave disorder, amid great pomp and noise, and under the patronage of honored names, without at least relieving, for the time, a certain proportion of cases; and practically it is of little import what the drug or remedy may be, if only the confidence of the sufferers is assured.

Men not only of general but of special experimental ability are constantly going far out of the way in scientific research through want of simple knowledge of the laws and phenomena of the involuntary life—a branch of physiology which, though of extreme interest and overflowing in suggestion, is so young and recent in its development that it is not yet taught in colleges or schools. The published monographs of the late Mr. Braid, of Manchester, show indisputably that their author was not without a certain genius for scientific research; but in all his philosophizing on the effects of fixed attention and straining of the eyes in the production of what has been known as hypnotism he missed utterly the discovery, or even the suspicion, of the great fact that trance, of which hypnotism is but one of numberless phases, was a subjective not an objective condition—existing in the subject's own brain—and that the manœuvrings by which he was wont to excite it were but one of infinite devices for acting upon the mind; thus Mr. Braid failed to solve the problem of trance. Similarly Professor Czermak—one of the inventors of the laryngoscope—though he made many experiments in the production of hypnotism in animals, likewise confounded the subjective with the objective, and did not arrive at the true explanation of his own experiments. Indeed, from the time of Mesmer down, all or nearly all the scientific studies and attempted scientific studies of trance, in any of its multiform phases, have been made valueless by this same non-recognition of the involuntary life, of which trance is the extreme expression. Confounding the subjective with the objective vitiates nearly all human philosophy.

Similarly Mr. Edison, in his experiments with those highly interesting phenomena that he supposes to indicate a new force, was so far misled by the muscular contractions of the tongue when applied to a block of iron, through which the suspected force was passing, as to conclude that an objective influence was acting, whereas, after the ele-

ment of error from the expectation of the experimenter was eliminated, it was quickly shown that the contractions were entirely subjective. Mr. Edison, I may say, is not only an inventor of phenomenal genius, but likewise a skilled and practiced experimentalist, and, as I found when making these and similar investigations with him, extraordinarily fertile in resources of method and device for wresting the secrets from nature, and usually alert against subtile sources of error; but, when drawn into the province of the involuntary life, he found himself, like men of science in general, insufficiently equipped with knowledge to even surmise, not to say provide for, the errors that may arise from the unconscious or involuntary action of mind on body.

In some instances the reverse mistake is made, and phenomena of the involuntary life are supposed to be volitional. In the case of the "Maine jumpers" or so-called "jumping Frenchmen" of Canada and the Maine woods—the incredible performances of which I have elsewhere described—it had for years been assumed, both by men of science and by the laity, that the movements were intentional, and within control. This conclusion, though most erroneous, was quite a natural one for those who have no knowledge of the relation of mind to its physical substratum.

An illustration of the second method of deception—doing nothing when the subject supposes we are doing something—is professing to apply electricity, putting the electrodes in position, and going through the motions, when no current is running, or when the connection is broken; in this way I have several times proved that patients were mistaken in inferring that electrical applications injured them; and, conversely, I have been able in one striking case to prove that the patient was right, and that a certain symptom was temporarily aggravated by the application.

THIRD SOURCE OF ERROR: *Intentional deception on the part of the subject.*—This element of error is so obvious that it would seem to be quite needless to refer to it; and yet it is constantly overlooked even in researches conducted by physiologists. To assume, as is often or usually done, that the subject on whom the experiment is made is honest in his relation to that experiment, because he has a general character for honesty, is always unscientific; and all experiments where such assumption is made must be ruled out of science.

Intentional as well as unintentional deception on the part of the subject can only be scientifically met by deception on the part of the experimenter. The methods of deceiving already described suffice to guard against all deception on the part of the subject, whether intentional or unintentional.

It is clear proof of the non-expertness of Zöllner, Wallace, Charcot, and Westphal, that in their published accounts of experiments with living human beings they assumed that, if the subjects were honest, the

results of the experiments must be accepted by science. Scientifically it makes no difference whether the subject on whom any such experiment is performed is honest or dishonest; the experiments are to be made without any reference to the moral character of the subject.

FOURTH SOURCE OF ERROR: *Unintentional collusion of third parties.*—By third parties are meant audiences, witnesses, bystanders, or assistants seen or unseen.

The best illustration of error from this source is the aid which audiences in the mind-reading experiments give to the performer by their silence, when he wanders away from the object looked for, and by their murmurs and applause when he approaches or reaches it. This is quite analogous to the cry of "hot" or "cold" in the game of "blind-man's-buff." So natural is it for errors from this cause to enter these investigations that I found it necessary, in all my researches in that department, to send all witnesses from the room, or to insist on their being absolutely silent, and even motionless, at every stage of the experiments.

FIFTH SOURCE OF ERROR: *Intentional collusion of third parties.*—Under this head comes the aid which assistants, known or unknown, *designedly* give to the subject experimented on. This, in the abstract, is one of the more readily suspected of all the six sources of error, but in the concrete very difficult to guard against, or even to detect, as is so brilliantly illustrated in the conjuring tricks of Houdin and Heller, and, it may be added also, in the operations of so-called "confidence-men."

The best and most mystifying tricks of illusionists, and sleight-of-hand performers of all kinds, are almost always done through some form of collusion, the time and method of which are so artfully arranged that only those of unusual acuteness or expert skill can at once detect them. The astounding success of clairvoyants and mediums in telling people what they already know, but which they suppose can not be known to the witch they are consulting, is oftentimes explained by this fifth source of error.

Intentional, deliberate deception, where no money is to be gained by deception, is much more common among the better classes than those who have not specially studied this subject would be willing to believe: it is an instructive fact in the psychology of lying, that some persons —usually, though not always, women—whose general character is of the highest, are in some special direction absolutely systematically untruthful all their lives long. An old merchant of New York once told me that a clerk in his employ, trustworthy in all business affairs, exact, scrupulous, just, had a habit of telling large stories in regard to what he had seen and done so firmly fixed that it was organically impossible for him to restrict himself to the facts, and that his statements in regard to matters outside of business were worthy of absolutely no credence.

I was once requested by a valued medical friend to aid him in some experiments with a case of alleged sixth sense, or the asserted power of

reading without the use of the eyes. The subject who made the claim was a lady of education, culture, and social position, universally and justly respected. In answer to the request, I stated that by deductive reasoning it was established as firmly as the Copernican theory, or the law of the persistence of force, that no human creature could have any such power, and that therefore it would be unscientific to investigate any such claim; but as an amusement, and for the sake of determining whether the deception was intentional or unintentional, I would suggest and prepare some tests in which all the six sources of error would be excluded. This was done. The tests were of course not taken, but the result of the investigation was to demonstrate the interesting psychological fact that for years a graceful and agreeable lady had been deceiving not only strangers and friends, but even her own husband, by means of the very old and familiar "ballot-trick," and a not especially adroit method of performing it. The puzzling cases of starving girls, of invalid clairvoyants, of mediumship, that are constantly infesting and astonishing civilized society, are in many instances to be similarly explained. The "mind-readers" were originally self-deceived, since the physiological interpretation of that phenomenon is too complex and profound to be suggested, not to say comprehended, by the mass of those who are accustomed to practice that art. But at the present time the public performers probably understand, in a general way, the philosophy of their success, at least enough to know that their claims of a sixth sense are baseless.

Lying, like stealing, may become a passion, and, in like manner also, may concentrate all its force in some one direction, for folly as well as wisdom has its specialties and hobbies: there is a monomania for deceiving, where naught is gained save its own gratification; one who is in all other directions honorable and just may become an inebriate of falsifying, and be half his days intoxicated thereby.

ATHEISM AND THE CHURCH.

By Rev. G. H. CURTEIS.

OMNIA EXEUNT IN—THEOLOGIAM.[1] No branch of science appears to consider itself complete, nowadays, until it has issued at last into the vexed ocean of theology. Thus, Biology writes "Lay Sermons" in Professor Huxley; Physics acknowledges itself almost Christian in Professor Tyndall; Anthropology claims to be religious in Mr. Darwin; and Logic, in Mr. Spencer, confesses that "a religious system is a normal and essential factor in every evolving society."[2]

[1] Everything issues into theology.

[2] Spencer, "Sociology" (seventh edition, 1878), p. 313.

It is only the second-rate men of science who loudly vaunt their ability to do without religion altogether, and proclaim their fixed and unchangeable resolve for its entire suppression. As well resolve to suppress the Gulf Stream or the eccentricity of the earth's orbit! If the horizon of man's thought is bounded on all sides by mystery, it is in simple obedience to the law of his nature that he gives some *shape* to that mystery. It were mental cowardice to shrink from facing it; it were positive imbecility to declare that the coast-line between known and unknown had no shape at all. Granted that the line be a slowly fluctuating one, and that conquests here and losses there reveal themselves in course of time, and one day become "striking" to the commonest observer, does that fact acquit of folly the Agnostic statement that, now and here, there is no thinkable line at all, no features to be described, nothing to sketch, no appreciable curves and headlands, no conception possible which shall integrate (for practical utility) that great Beyond whose boundaries, on the hither side at least, are known to us? Men who can only attend to one thing at a time, and whose "one thing" is the field of a microscope or "the anatomy of the lower part of the hindmost bone of the skull of a carp,"[1] may perhaps escape the common lot of manhood by ceasing to be "men," in any ordinary sense of the word. But, for people who live in the open air and sunshine of common life, there is the same necessity for a religion as there is for that mental map of our whereabouts that we all carry with us in our brains. Let any one recall his sensations when he has at any time been overtaken in a fog or a snow-storm, and when all his bearings have been blotted out, then he will readily understand the need which all men feel for a theology of some kind, and he will appreciate what the old-school divines meant when they said that "Theology was the queen and mistress of the sciences," harmonizing and gathering up into architectonic unity all the multifarious threads that the subordinate sciences had spun.

I. One is driven, nowadays, to repeat both in public and private these very obvious reflections, owing to the extraordinary persistence with which certain philosophers think fit to inform us that we are all making a great mistake; that we can do very well without a religion; and that, though it is true "man can not live by bread alone," but must have *ideas*, yet the creed by which he may very well make shift to live is this—"SOMETHING IS."[2] In point of brevity there is here little to desire. The Apostles' Creed is prolix by comparison, and although we might fairly take exception to "some-thing," as embodying two very concrete acts of the imagination, and therefore capable

[1] Cf. Mivart, "Contemporary Evolution" (1876), p. 134.

[2] Physicus, "Examination of Theism" (1878), p. 142: "What was the essential substance of that [atheistic] theory? Apparently it was the bare statement of the unthinkable fact that Something Is. The *essence* of atheism I take to consist in the single dogma of self-existence as itself sufficient to constitute a theory of things."

of further logical "purification," it were ungenerous to press the objection too far. This creed is purer than that of Strauss: "We believe in no God, but only in a self-poised and, amid eternal changes, constant universum."[1] It is wider than that of Hartmann: "God is a personification of force."[2] It is simpler than that of Matthew Arnold: God is "a power, not ourselves, that makes for righteousness."[3] It is more intelligible than that of J. S. Mill: "A Being of great but limited power, how or by what limited we can not even conjecture"—a notion found also in Lucretius and in Seneca.[4] It is more theological than that of Professor Huxley: "The order of nature is ascertainable by our faculties, and our volition counts for something in the course of events."[5] It is similar to that of the ancient Brahmans: "That which can not be seen by the eye, but by which the eye sees, that is Brahma; if thou thinkest thou canst know it, then thou knowest it very little; it is reached only by him who says, 'It is! it is!'"[6] And considering that this formula is very nearly what is said also by the Fathers of the Church, what better *formula concordiæ*[7] between science and theism could we require? For instance, Clemens Alexandrinus (A. D. 200) echoes St. Paul's "Know Him, sayest thou! rather art known of him," with the confession, "We know not what he is, but only what he is not"; Cyril of Jerusalem (A. D. 350) says, "To know God is beyond man's powers"; St. Augustine (A. D. 400), "Rare is the mind that in speaking of God knows what it means"; John of Damascus (A. D. 800), "What is the substance of God or how he exists in all things, we are Agnostics, and can not say a word"; and in the middle ages, Duns Scotus (A. D. 1300): "Is God accessible to our reason? I hold that he is not."[8]

It seems, then, there is a consensus among all competent persons, who have ever thought deeply on the subject, that the real nature of that Power which underlies all existing things is absolutely unknown to man. And it is allowable, therefore, in the last resort, to fall back upon Spinoza's word "sub-stance"; and to accept—if charity so require—as the common basis for theological reunion, the Agnostic formula, "Something Is."

But then, unless some means be found for instantly paralyzing the restless energy of human inquiry, the next question is inevitable: *What* is that Something? What are its qualities, its attributes?

[1] Strauss, "Der alte und der neue Glaube" (fourth edition, 1873), p. 116.

[2] Hartmann, "Gott und Naturwissenschaft" (second edition, 1872), p. 14.

[3] M. Arnold, "Literature and Dogma," p. 306.

[4] J. S. Mill, "Essays on Religion," p. 124. Cf. Lucretius, vi., and Seneca, Nat. Qu. i. 1.

[5] Huxley, "Lay Sermons."

[6] The "Upanishad": *ap.* Clarke's "Ten Great Religions," p. 84.

[7] Formula of agreement.

[8] Gal. iv. 9; Clem. Alex., Strom. v. 11; Cyr. Jer., Cat. Lect. xi. 3; Aug., Confess. xiii. 11; Joh. Dam., De Fide Orthod. i. 2; Duns Scotus, In Sent. i. 3. 1.

How are we to conceive of it? Given (in Aristotelian phrase) its *οὐσια*,[1] what is its *ποιότης*,[2] its *ποσότης*,[3] and the rest, which go to make up its idea? "Existence" is, after all, only one of our three necessary forms of thought: "Space" and "Time" are also necessary to our thinking. And it is in vain for pure logicians to put on papal airs, to forbid the question, to cry *Non possumus*,[4] and to stifle all free thinking. It is useless to say: "We have already, with razors of the utmost fineness, split and resplit every emergent phenomenon; we have, by assiduous devotion to the one single and undisturbed function of analysis, examined every possible conception that man can form, and have discovered everywhere compound notions, ideas that are 'impure' and capable of further logical fissures: salvation is only possible by the confession that 'Something Is'; there rest and be thankful!" It is all of no avail. *Naturam expellas furca*[5]—she is sure to return in armed revolt, and to demand, Who told thee that thou wast thus nakedly equipped? Reason is one thing; but imagination is also another. If analysis is a power of the human mind, so also is synthesis. If you can not think at all without using the one, neither can you without employing the other. Take, for instance, a process of the "purest" mathematics—"twice six is twelve"; you were taught that probably with an abacus, and the ghost of the abacus still lingers in your brain. "The square of the hypotenuse": you saw that once in a figured Euclid, and you learned thereby to form any number of similar mental figures for yourself. No: you may call the methods by which mankind think "impure," or attach to them any other derogatory epithet you please; but mankind will deride you for your pains, and will reply: "The philosopher who will only breathe pure oxygen will die; he that walks on one leg, and declines to use the other, will cut but a sorry figure in society; he that uses only one eye will never get a stereoscopic view of anything. Use, man, the *compound* instrument of knowledge your nature has provided for you, and you will both see and live." Why, even so determined a logician as "Physicus" is obliged sometimes to admit that "this *symbolic* method of reasoning is, from the nature of the case, the only method of scientific reasoning which is available."[6] And Professor Tyndall, in the November number of another Review, after complaining that "it is against the mythologic scenery of religion that Science enters her protest," finds himself also obliged to mythologize; for he adds (seven pages further on): "How are we to *figure* this molecular motion? Suppose the leaves to be shaken from a birch-tree, . . . and, *to fix the idea*, suppose each leaf," etc. And so Professor Cooke writes:

> I can not agree with those who regard the wave-theory of light as an established principle of science. . . . There is something concerned in the phenomena of light which has definite dimensions. We *represent* these dimensions to our

[1] Essence. [2] Quality. [3] Quantity. [4] We can not.
[5] Put nature out with a pitchfork. [6] "Examination of Theism," p. 84.

imagination as wave-lengths, and *we shall find it difficult to think clearly* upon the subject without the aid of this wave-theory."[1]

In short, it is obvious that without the help of this mythologic, poetic, image-forming faculty, all our pursuit of truth were in vain. And therefore, starting from the common basis of a confession that "something is," we are more than justified, we are obeying a necessary law of our nature, in asking WHAT that eternal substratum of existence is, and with what morphologic aid the imagination may best present it for our contemplation.

But here the pure logician may perhaps retort: "You forget that the conceptions men form of things are, at their very best, nothing more than human, and therefore *relative* conceptions. A fly or a fish probably sees things differently. And an inhabitant of Mercury or Saturn might form a conception of the universe bearing little resemblance to yours."[2] Quite true; but logicians there, too, would probably be heard to complain that, colored by Saturnian or Mercurian relativities, truth was sadly impure, and was, in fact, attained by no one but themselves. Nay, in those other worlds priests of Logic might be found so wrapped in superstition as to launch epithets of contempt on all who approached to puncture their inflated fallacies, and who devoutly believed that a syllogism did *not* contain a *petitio principii*[3] neatly wrapped up in its own premises, and an induction was *not* an application of a preëxisting general idea, but a downright discovery of absolute truth. If from such afflictions we on earth are free, it is because the common sense of mankind declares itself serenely content with the relative and the human; because, while fully aware (from our schoolboy days) that all our faculties—reason among the rest—are limited and earthly, we have faith that "all is well" in mind, as it certainly is in matter; and because we smile at the simplicity of our modern wranglers, who can only analyze down as far as "SOMETHING," when their Buddhist masters two thousand years ago had dug far deeper, viz., to NOTHING:

> The mind of the supreme Buddha is swift, quick, piercing, because he is infinitely "pure." Nirwana is the destruction of all the elements of existence. The being who is "purified" knows there is no Ego, no self; all the afflictions connected with existence are overcome, all the principles of existence are annihilated, and that annihilation is Nirwana.[4]

The Churchman, therefore, holds himself so far justified in claiming

[1] Cooke, "The New Chemistry" (fourth edition, 1878), p. 22.

[2] "Physicus" (p. 143) rides this logical hobby far beyond the confines of the sublime. He demands of the theist to show that his "God is something more than a mere causal agent which is 'absolute' in the grotesquely restricted sense of being independent of one petty race of creatures with an ephemeral experience of what is going on in one tiny corner of the universe."

[3] Begging the question.

[4] Hardy, "Eastern Monachism," p. 291.

the modern atheist as his ally. They are at least traveling both together on the high-road which leads from a destructive nihilism toward a constructive religion. Only the atheist has thought it his duty to go back again to the beginning, and to measure industriously the same ground that the Church had gone over just two thousand four hundred years ago, when the great "Something is" addressed itself to man through Moses in the word "I am," or Jehovah (יהוה, Absolute Existence).[1]

But perhaps the pure logician may attempt another reply. Finding us not in the least disconcerted by hearing, once again, the familiar truth that all our faculties are limited, he may attempt to shatter our serenity by an announcement of a more novel kind. He may say: Not only is the imagery with which you clothe, represent, and conceive the Self-existent merely relative and human, but—far more damning fact—it is all a development. It has all grown with the growth of your race. Environment and heredity have supplied you with all your forms of thought. Even your "conscience is nothing more than an organized body of certain psychological elements which, by long inheritance, have come to inform us by way of intuitive feeling how we should act for the benefit of society."[2]

Be it so. The proof has not yet been made out. But since these evolution doctrines are (as Dr. Newman would say) "in the air," it is more consonant to the ruling ideas which at present dominate our imagination to conceive things in this way. Indeed, to a large and increasing number of Churchmen the evolution hypothesis appears, not only profoundly interesting, but probably true. They find there nothing to shake their faith, and a good deal to confirm it. Man is what he is, in whatever way he may have become so. And how atheists can persuade themselves that this beautiful theory of the divine method helps their denial of a deity, the modern school of theologians is at a loss to understand. For the cosmic force whom Christians worship has, from the very beginning, been represented to them, not as a fickle, but as a continuous and a law-abiding energy. "My Father worketh hitherto," said Christ. "Not a sparrow falleth to the ground" without his cognizance. "The very hairs of your head are all numbered." "In Him we live and move and have our being." Pictorial expressions, no doubt. But what words could more clearly indicate the unbroken continuity of causation in nature than these texts from the Christian Scriptures? And it is surely the establishment of a continuous, as distinct from an intermittent, agency in nature which forms the leading point of interest both to science and to the Church, at the present day, as against a shallow deism. If, therefore, man's imaginative and moral faculties, as we know them now, are a development from former and lower—yes, even from savage, from bestial, from material—antecedents, what is that to us? Of man's logical powers the self-same thing has to be said. Why,

[1] Exodus vi. 3.

[2] "Physicus," p. 31.

then, should Logic give itself such mighty airs of superiority and forget its equally humble origin? How does it affect the truthfulness in relation to man, and the trustworthiness, for all practical purposes, of our image-forming faculties, that it is what it is only after long evolution, and that the race had a fœtal period as well as the individual?

The upshot, then, of the whole discussion is surely this: The Absolute is confessedly inconceivable by man. All our mental faculties are in the same category: they are all finite, relative, imperfect. But then they are suited to our present development and environment. Faith in them is therefore required, and a bold masculine use of them all. For in nature, as in grace, "God hath not given us the spirit of fear, but of power and of love and of a sound mind."[1] If, then, there are questions into which mere analytic reasoning can not enter, if Logic is powerless, for instance, before a musical score, and is struck dumb before the self-devotion of Thermopylæ, or the unapproachable self-sacrifice of Calvary, by what right are we forbidden to employ these other faculties which help us, and whose constructive help brings joy and health and peace to our minds? The many-colored poetical aspect of things is, assuredly, no less "pure" and far more interesting than the washed-out and colorless zero reached by interminable analysis. The colored sunlight is no less "pure," and it reveals a great deal more of truth, than "the pale moon's watery beams." And so we venture to predict that a constructive Christianity which, *πολυμέρως καὶ πολυτρόπως*,[2] reveals the cosmic force and unity to the millions of men, will ever hold its own against a merely destructive Buddhism, whether ancient or modern; and, long after pure Logic has said its last word and—with a faint cry, "Something perhaps is"—has evaporated into Nirwana, will continue its thrice-blessed efforts to rear a palace of human thought, will handle with reserve and dignity the best results of all the sciences, and will integrate (with courage and not despair) the infinite contributions of all phenomena into a theology of practical utility to the further evolution of the human race.

For evolution there has certainly been. And in spite of all that has been said to the contrary,[3] the moral atmosphere which has from age to age rendered mental progress possible has been, for the most part, engendered by religion, and, above all, by the confidence, peace, and brotherhood preached by the Christian Church. No doubt religion was cradled amid gross superstitions; and only by great and perilous transitions has it advanced from the lower to the higher. It was a great step from the fetich and the teraphim to the animal and plant

[1] 2 Timothy i. 7.

[2] At sundry times and in divers manners.

[3] Draper, "The Conflict between Religion and Science," New York, 1873. This otherwise admirable work is disfigured throughout by a prejudice against religion, as a factor in human progress, which is almost childish. The learned author surely forgets his own words, "No one can spend a large part of his life in teaching science, without partaking of that love of impartiality and truth which philosophy incites" (p. ix.).

symbols of Egypt and Assyria. It was another great step to Baal, the blazing sun, and Moloch, wielder of draught and sunstroke, and Agni, friendly comrade of the hearth. But when astronomy and physics had reached sufficient growth to master all these wonders, and to predict the solstices and the eclipses, then the fullness of times had come once more; and now the greatest religious transition was accomplished that the human race has ever seen—a transition from the physical, and the brutal, and the astral, to the human and the moral, in man's search after a true (or the to him truest possible) representation of the infinite forces at play around him. In Abraham the Hebrew—עברי, the man who made the great transition—this important advance is typified for the Semitic races; for others, the results only are seen in the Olympian conceptions of Hesiod and Homer. For here we have, at last, the nature-forces presided over and controlled after a really human fashion. Crude, and only semi-moral, after all, as was this earliest humanizing effort, still human it was—not mechanical nor bestial. And it opened the way for Socrates to bring down philosophy, too, from heaven to earth, for Plato to discuss the mental processes in man, and apply them (writ large) to the processes of nature, and for Moses to elaborate with a divine sagacity a completely organized society, saturated through every fiber with this one idea—the unity of all the nature-forces, great and small, and their government, not by hap-hazard, or malignity, or fate, but by what we men call LAW. "Thou hast given them a law which shall not be broken." For this word "law" distinctly connotes rationality. It implies a quality akin to, and therefore expressible in terms of, human reason. Its usage on every page of every book of science means that; and repudiates, therefore, by anticipation, the dismal invitations to scientific despair with which the logicians *à outrance* are now so pressingly obliging us.

This grand transition, then, once made, all else became easy. The human imagination, the poetic or plastic power lodged in our brain, after many failures, had now at last got on the high-road which led straight to the goal. Redemption had come; it only needed to be unfolded to its utmost capabilities. Dull fate, dumb, sullen, and impracticable, had been renounced as infra-human and unworthy. Let stocks and stones in the mountains and the forests be ruled by it; not free, glad, and glorious men! Brute, bestial instinct also had been renounced, as contemptible and undivine in the highest degree. And so, at last, the culminating point was attained. The human-divine of Asiatic speculation, and the divinely-human of European philosophy, met and coalesced; and from that wedlock emerged Christianity. The "Something is" of mere bald analytic reasoning had become clothed by the imagination with that perfect human form and character than which nothing known to man is higher; and that very manhood, which is nowadays so loudly asserted by positivists and atheists to be the most divine thing known to science, was precisely the form in which

the new religion preached that the great exterior existence, the Something Is, the awful "I AM," can alone be presented intelligibly to man. For "No man shall see Jehovah and live," says the Old Testament: "No man hath seen God at any time," says the New Testament; the Son of man, who is *εἰς τὸν κόλπον τοῦ πατρὸς* [1]—projected on the bosom of the absolute "I am"—he hath declared him.

Of this language in St. John's Gospel, it is obvious that Hegel's doctrine—echoed afterward by Comte and the positivists—is a sort of variation set in a lower key. In humanity, said he, the divine idea emerges from the material and the bestial into the self-conscious. Humanity presents us with the best we can ever know of the divine. In "the Son of man" that SOMETHING which lies behind, and which no man can attain to, becomes incarnate, visible, imaginable. But it can not surely be meant by these philosophers that in the sons of men *taken at hap-hazard* the Divinity, the great Cosmic Unknown, is best presented to us. It can not possibly be maintained that in the Chinese swarming on their canals, in the hideous savages of Polynesia, or in the mobs of our great European capitals, the "Something is" can be effectively studied, idealized, adored. No, it were surely a truer statement that humanity concentrated in its very purest known form, and refined as much as may be from all its animalism, were the clear lens (as it were) through which to contemplate the great Cosmic Power beyond. It is, therefore, a SON of man, and not the ordinary sons of men, that we require to aid our minds and uplift our aspirations. Mankind is hardly to be saved from retrograde evolution by superciliously looking round upon a myriad of mediocre realities. It must be helped on, if at all, by a new variety in our species suddenly putting forth in our midst, attracting wide attention, securing descendants, and offering an ideal, a goal in advance, toward which effort and conflict shall tend. We must be won over from our worldly lusts and our animal propensities by engaging our *hearts* on higher objects. We must learn a lesson in practical morals from the youth who is redeemed from rude boyhood and coarse selfishness by love. We must allow the latent spark of moral desire to be fanned into a flame, and, by the enkindling admiration of a human beauty above the plane of character hitherto attained by man, to consume away the animal dross and prepare for new environments that may be in store for us. What student does not know how the heat of love for truth not yet attained breaks up a heap of prejudices and fixed ideas, and gives a sort of molecular instability to the mind, preparing it for the most surprising transformations? Who has not observed the development of almost a new eye for color, or a new ear for refinements in sound, by the mere constant presentation of a higher æsthetic ideal? And just in the same way, who that knows anything of mankind can have failed to perceive that the only successful method by which character is permanently improved is by employ-

[1] On the Father's bosom.

ing the force of example, by accumulating on the conscience reiterated touches of a new moral color, and by bringing to bear from *above* the power of an acknowledged ideal, and (if possible) from *around* the simultaneous influence of a similarly affected environment?

Baptize now all these truths, translate them into the ordinary current language of the Church, and you have simply neither more nor less than the gospel of Jesus Christ. And as carbon is carbon, whether it be presented as coal or as diamond, so are these high and man-redeeming verities—about the inscrutable "I am," and his intelligible presentment in a strangely unique SON OF MAN, and the transmuting agency of a brotherhood saturated with his Spirit and pledged to keep his presence ever fresh and effective—verities still, whether they take on homely and practical or dazzling and scientific forms. And the foolish man is surely he who, educated enough to know better, scorns the lowly form, and is pedantic enough to suggest the refinements of the lecture-room as suitable for the rough uses of every-day life. A man of sense will rather say: Let us by all means retain and—with insight and trust—employ the homely traditional forms of these sublime truths: let us forbear, in charity for others, to weaken their influence, and so to cut away the lower rounds of the very ladder by which we ourselves ascended: and let us too, in mercy to our own health of character, decline to stand aloof from the world of common men, or to relegate away among the lumber of our lives the *ἔπεα φωνᾶντα συνέτοισιν*[1] that we learned of simple saintly lips in childhood. Rather, as the SON OF MAN hath bidden us, we will "bring out of our treasures things both new and old"; will remember, as Aquinas taught, that "nova nomina antiquam fidem de Deo significant"[2]; and will carry out in practice that word well spoken in good season, "It is not by rejecting what is formal, but by interpreting it, that we advance in true spirituality."[3]

II. On the other hand, if men of science are to be won back to the Church, and the widening gulf is to be bridged over which threatens nowadays the destruction of all that we hold dear, it can not be too often or too earnestly repeated, *The Church must not part company with the world she is commissioned to evangelize.* She must awake both from her renaissance and her mediæval dreams. To turn over on her uneasy couch, and try by conscious effort to dream those dreams again, when daylight is come and all the house is fully astir, this surely were the height of faithless folly. An animating time of action is come, a day requiring the best exercise of skill and knowledge and moral courage. Shall we hear within the camp, at such a moment as this, a treasonable whisper go round: "By one act of mental suicide we may contrive to escape all further exertion; science is perplexing, history is full of doubts, psychology spins webs too fine for our self-indulgence

[1] Words that have a meaning for those who understand.

[2] The new terms signify the ancient faith concerning God.

[3] "The Patience of Hope," p. 70.

even to think of? Why not make believe very hard to have found an infallible oracle, and determine once for all to desert our post and 'jurare in verba magistri'[1]?" It is true that history demonstrates beyond a doubt that Jesus and his apostles knew nothing of any such contrivance. But never mind! "A Catholic who should adhere to the testimony of history, when it appears to contradict the Church, would be guilty not merely of treason and heresy, but of apostasy."[2] Yes, of treason to Rome, but of faithful and courageous loyalty to Christ. "I am the truth," said Christ. "The truth shall make you free." Speak the truth in love, prove all things, hold fast that which is true, said his apostles. How can it ever be consonant to his will that the members of his brotherhood should conspire together to make believe that white is black at the bidding of any man on earth? The Church of England, at any rate, has no such treason to answer for. Her doctrinal canons, by distinctly asserting that even "General Councils may err and have erred," and by a constant appeal to ancient documents, universally accepted, but capable of ever-improving interpretation, have averted the curse of a sterile traditionalism. No new light is at any time inaccessible to her. Every historical truth is treasured, every literary discussion is welcome, every scientific discovery finds at last a place amid her system. Time and patience are, of course, required to rearrange and harmonize all things together new and old; and a claim is rightly made that new "truths" should first be substantiated as such, before they are incorporated into so vast and widespread an engine of popular education as hers. But, with this proviso, "Theology accepts every certain conclusion of physical science as man's unfolding of God's book of nature."[3] It is therefore most unwise, if any of her clergy pose themselves as hostile to new discoveries, whether in history, literature, or science. It may be natural to take up such an attitude; and a certain impatience and resentment at the *manner* in which these things are often paraded, in the crudest forms and before an unprepared public, may be easily condoned by all candid men. But such an attitude of suspicion and hostility between "things old" and "things new" goes far beyond the commission to "banish and drive away all strange and erroneous doctrines contrary to God's word." For this commission requires proof, and not surmise, that they are erroneous; and the Church has had experience, over and over again, how easy and how disastrous it is to banish from the door an unwelcome guest, who was perhaps nothing less than an angel in disguise. The story of Galileo will never cease, while the world lasts, to cause the enemies of the Church to blaspheme. Yet of late years it has been honestly confessed by divines that "the oldest and the youngest of the natural sciences, astronomy and geology, so far from being dangerous, . . . seem providentially destined to engage

[1] Swear as a master bids.

[2] Abbé Martin, "Contemporary Review," December, 1878, p. 94.

[3] Dr. Pusey, "University Sermon," November, 1878.

the present century so powerfully that the ideal majesty of infinite time and endless space might counteract a low and narrow materialism."[1]

This experience ought not to be thrown away. No one, who has paid a serious attention to the progress of the modern sciences, can entertain a doubt that all the really substantiated discoveries which have been supposed to contravene Christianity do in reality only deepen its profundity and emphasize its indispensable necessity for man. Never before, in all the history of mankind, has the Deity seemed so awful, so remote from man, so mighty in the tremendous forces that he wields, so majestic in the permanence and tranquillity of his resistless will. Never before has man realized his own excessive smallness and impotence; his inability to destroy—much more, to create—one atom or molecule; his dependence for life, for thought, for character even, on the material environment of which he once thought himself the master. The forces of nature, then, have become to him once more, as in the infancy of his race, almost a terror. And poised midway, for a few eventful hours, between an infinite past of which he knows a little and an infinite future of which he knows nothing, he is tempted to despair of himself and of his little planet, and in childish petulance to complain, "My whilom conceit is broken; there is nothing else to live for." And amid these foolish despairs, a voice is heard which says: "Have faith in God! have hope in Christ! have love to man! Knowledge of this tremendous substratum of all being it is not for man to have: his knowledge is confined to phenomena and to very human (but sufficient) conceptions of the so-called laws by which they all cohere. But these three qualities are moral, not intellectual, virtues. For the Church never teaches that God can be scientifically known; she never offers certainty and sight, but only "hope," in many an ascending degree; she does not say that God is a man, a person like one of us—that were indeed perversely to misunderstand her subtile terminology—but only a MAN has appeared, when the time was ripe for him, in whom that awful and tremendous existence has shown us something of his ideas, has made intelligible to us (as it were by a word to the listening ear) what we may venture to call his "mind" toward us, and has invited us—by the simple expedient of giving our heart's loyalty to this most lovable Son of man—to reach out peacefully to higher evolutions, and to commit that indestructible force, our life, to him in serene well-doing to the brotherhood among whom his Spirit works, and whose welfare he accounts his own.

Is not this *humanizing* of the great Existence, for moral and practical utility, and this *utterance* (so to speak) of yet another creative word in the ascending scale of continuous development, and this *socializing* of his sweet, beneficent Spirit in a brotherhood as wide as the world, precisely the religion most adapted to accord with modern science?

[1] Kalisch, "On Genesis," p. 43.

Yet no one can listen to ordinary sermons, no one can open popular books of piety or of doctrine, without feeling the urgent need there is among Churchmen for a higher appreciation of the majestic infinitude of God. It is true that, in these cases, it is the multitude and not the highly educated few who are addressed; and that, even among that multitude, there are none so grossly ignorant as to compare the Trinity to "three Lord Shaftesburys," and not many so childish as to picture "one Almighty descending into hell to pacify another."[1] Such petulance is reserved for men of the highest intellectual gifts, who—whether purposely or ignorantly, it is hard to say—have stooped to provide their generation with a comic theology of the Christian Church. But, after all, it is impossible not to feel that the shadows of a well-loved past are lingering too long over a present that might be bright with joyous sunshine; that the subtilties of the schoolmen are too long allowed to darken the air with pointless and antiquated weapons; that the Renaissance, with its literary fanaticism, still reigns over the whole domain of Christian book-lore; and that the crude conceptions of the Ptolemaic astronomy have never yet, among ecclesiastics, been thoroughly dislodged or replaced by the far more magnificent revelations of the modern telescope. It is not asserted that no percolation of "things new" is going on. It is not denied that as in the first century a change in ideas about the priesthood carried with it a change in the whole religious system of which that formed the axis,[2] so now a change in ideas about the earth's position in space demands a very skillful and patient readjustment of all our connected ideas. But such a readjustment of the old Semitic faith was effected, in the first century, by St. Paul; and there is no reason to think that the Church is unequal to similar tasks now. And in this country especially there is an established and organized "Ecclesia docens"[3] which probably never had its equal in all Church history for the literary and scientific eminence of its leading members. For such a society to despair of readjusting its theology to contemporary science, or idly to stand by while others effect the junction, were indeed a disgraceful and incredible treason; so incredible that—until it be proved otherwise—no amount of vituperation or unpopularity should induce any reflecting Englishman to render that work impossible by allowing his Church to be trampled down, and its time-honored framework to be given up as a spoil to chaos.

But there is yet another element in this question which binds the Church of Christ to give to its solution the very closest and most indefatigable attention. It is this: that from every science there arises nowadays a cry like that addressed to Jesus himself when on earth, "Lord, help me!" It is not as if atheism were satisfied with itself. In the pages of the "National Reformer" and similar organs of aggres-

[1] M. Arnold, "Literature," etc. (1873), p. 306. Spencer, "Sociology" (seventh edition, 1878), p. 208.

[2] Hebrews vii. 12.

[3] Teaching Church.

sive free thought we are amused with the buoyant audacity of the "young idea." Yet even there we find many a passage which calls forth the sincerest sympathy. Take, for instance, the following:

> There are few reflective persons who have not been, now and again, impressed with awe as they looked back on the past of humanity. . . . It is then that we see the grandest illustrations of that unending necessity under which, it would seem, man labors, the necessity of abandoning ever and again the heritage of his fathers, . . . of continually leaving behind him the citadel of faith and peace, raised by the piety of the past, for an atmosphere of tumult and denial. . . . Whatever may be our present conclusions about Christianity, we can not too often remember that it has been one of the most important factors in the life of mankind."[1]

This is touching enough—though perhaps the stolid aggressiveness which knows, as yet, no relentings, is really a far more tragic spectacle. But there are other lamentations, uttered of late years by distinguished atheists, which might move a heart of stone, much more should stir the energies of every Christian teacher—himself at peace—to seek by any sacrifice of his own ease or settled preconceptions an "eirenicon," a method of conciliation, an opening for a mutual confession of needless estrangement and provocation.

> Does that new philosophy of history which destroys the Christian philosophy of it afford an adequate basis for such a reconstruction of the ideal as is required? Candidly we must reply, "Not yet." . . . Very far are we from being the first who have experienced the agony of discovered delusion. . . . Well may despair almost seize on one who has been, not in name only, but in very truth, a Christian, when that incarnation which had given him in Christ an ever-living brother and friend is found to be but an old myth [of Osiris] with a new life in it.[2]
>
> The most serious trial through which society can pass is encountered in the exuviation of its religious restraints.[3]
>
> Never in the history of man has so terrific a calamity befallen the race as that which all who look may now behold advancing as a deluge, black with destruction, resistless in might, uprooting our most cherished hopes, ingulfing our most precious creed, and burying our highest life in mindless desolation. The flood-gates of infidelity are open, and atheism overwhelming is upon us. . . . Man has become, in a new sense, the measure of the universe; and in this, the latest and most appalling of his soundings, indications are returned from the infinite voids of space and time that his intelligence, with all its noble capacities for love and adoration, is yet alone—destitute of kith or kin in all this universe of being. . . . Forasmuch as I am far from being able to agree with those who affirm that the twilight doctrine of the "new faith" is a desirable substitute for the waning splendor of "the old," I am not ashamed to confess that, with this virtual negation of God, the universe to me has lost its soul of loveliness. And when at times I think, as think at times I must, of the appalling contrast between the hallowed glory of that creed which once was mine and the lonely

[1] Bradlaugh's "National Reformer," October 6, 1878.

[2] Stuart Glennie, "In the Morning Land" (1873), pp. 29, 378, 431.

[3] Draper, "Religion and Science" (eleventh edition, 1878), p. 328.

mystery of existence as now I find it—at such times I shall ever feel it impossible to avoid the sharpest pang of which my nature is susceptible.[1]

It is well that Churchmen should be aware of this state of things; and especially that the clergy, when they are tempted to have their fling (secure from all reply) against the so-called "infidel," should bear in mind how often the bravery of defiant arrogance is a mere mask to cover a sinking heart. For pity's sake, therefore, as well as for their own sake, the clergy should guard against two gross but common mistakes: 1. The mistake of abusing modern science, and depreciating its unquestionable difficulties in relation to the established theology; 2. The still more fatal blunder of trusting to worn-out tactics and to the "artillery" of Jonathan and David for the reduction of these modern earthworks. "To the Greeks became I as a Greek," said St. Paul. And so must the minister of Christ in these days make up his mind to bring home the gospel to his own countrymen, with all their faults and peculiarities; and to the Englishmen of the nineteenth century must become an Englishman of the nineteenth century, that he "may by all means save some."

But no success will be obtained, unless Churchmen will remember that the vast domains recently conquered by science are (practically speaking) assured and certain conquests. They are no encroachment, but a rightful "revindication" of scientific territory. And, accepted in a friendly spirit, harmonized with skill and boldness, and consecrated (not cursed) in the Master's name, they bid fair to become a new realm whereon his peace-bringing banner may be right royally unfolded, and where, even in our own day, the beginning of a permanent unity may certainly be effected. And this must be attempted by a brave and telling proclamation of the great Christian doctrines—that the awful self-existent "I AM" is none other than "our Father in heaven"; that Christ, the blameless Son of man, is the best image of his person; and that his pure Spirit, brooding over the turbid chaos of human society, offers the surest means and pledge of a future Cosmos, where "life" may perhaps transcend these baffling veils of space and time, and, in forms "undreamed of by our philosophy," display the boundless riches of nature and of God.—*Contemporary Review.*

THE STING OF THE HONEY-BEE.[2]

PERHAPS there is no object more common in the cabinets of microscopists than mounted specimens of bee-stings. Almost every popular work on the microscope describes and figures them, but it is

[1] Physicus, "On Theism," pp. 51, 63, 114.

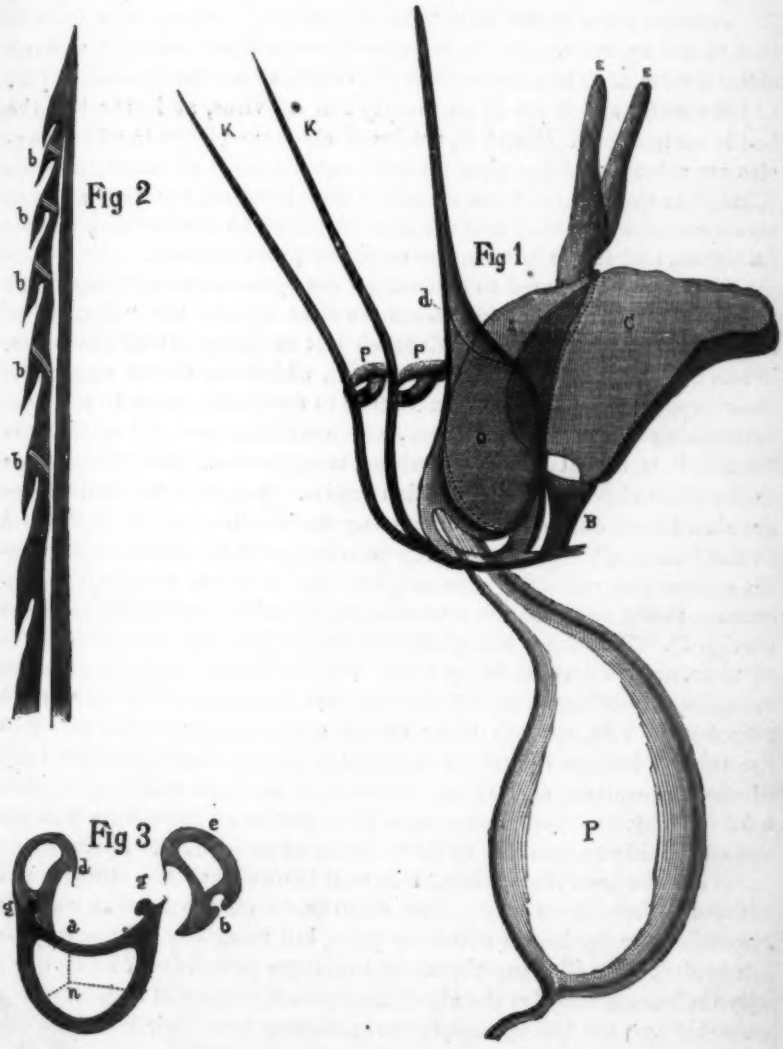
[2] Abstract from a paper, by J. D. Hyatt, in the "American Quarterly Microscopical Journal," October, 1878.

only within a few months that the true structure of these organs has been made known. Mr. J. D. Hyatt, of this city, has been studying the subject for the past eight years, and his recent discoveries have shown that the ordinary descriptions are incorrect and founded upon mere inferences, drawn from the appearance of the organ as usually dissected and mounted. There are no less than eight discoveries, for which we are indebted to the labors of this gentleman, and it is our intention to present some of these as briefly as possible.

By reference to the cuts the following descriptions will be made clear: Fig. 1 represents the entire apparatus of the sting of the honey-bee, with the muscles removed, showing only the hard parts and the poison-gland (*P*). The lancets (*K K*) are drawn out from their natural position to show their structure more clearly. The sting is usually described as having two barbed lancets (*K K*) which move in and out of the "sheath" (*D*), the inner sides of the lancets being channeled, so that when they are thrust out together they form a tube through which the poison enters the wound. It appears, however, that the so-called "sheath" does not inclose the lancets in any part, and therefore is not a sheath, as formerly supposed. Moreover, while the virus may, and undoubtedly does, pass along the tubular space between the lancets, this is not the course it follows to reach the bottom of the wound. A far more elaborate arrangement, a sort of miniature hydraulic ram, forces the fluid through the lancets themselves, and this is one of the most recent discoveries. By examining the lancets with a rather high power, it will be seen that each appears to be tubular, and that the tube runs down nearly to the apex, but always disappears before reaching the end. From this main tube, and just back of each of the last five teeth, we notice fine branch-tubes which open on the surface between them. All this is well shown in Fig. 2, the branch-tubes opening at the points *b b b b b*. This figure represents the lower part of one of the lancets, showing the shape of the barbs and the extremely sharp point. The lancet is thus seen with a power of four hundred and fifty diameters; the point of the finest sewing-needle magnified to the same extent would appear as blunt as the end of a crowbar. Although the tubular appearance was evident to any one who looked for it, the next step was to prove that the lancets were in truth hollow, for it is not safe to rely upon mere appearances when using the microscope. Mr. Hyatt succeeded in proving their tubular nature in several ways: he succeeded in forcing liquid through them, first by a little delicate manipulation, and finally by cutting thin transverse sections and mounting them so as to view them on end. One of these sections, which shows the form of the lancet and the tubular opening passing through it, is shown at *c*, Fig. 3.

Following the lancet from the apex toward the larger end we pass the gracefully curved barbs to a smooth portion, and then reach a curious projection (Fig. 1, *p*), firmly braced and attached to the lancet as

seen in the figure. When in the natural position these projections lie within the "sheath" (*D*). These are known as the stop-valves. The tubes of the lancets terminate just back of where the stop-valves are attached, here opening into the cylindrical portion of the "sheath."



We pass now from the lancets to the "sheath" (Fig. 1, *D*). The general shape is well shown in the figure. The cylindrical portion (*D*) suddenly contracts, forming a shoulder at *d*, and a slender portion extends for some distance beyond. Along the straight edge the lancets

run in the manner shown in Fig. 3. In this figure the darker portion (*n*) represents a cross-section of the "sheath," the two lighter pieces (*b* and *d*) are cross-sections of the lancets, one (*d*) *in situ*. Running the entire length of the "sheath" we find the T-rail projections (*g g*) along which the lancets slide, being channeled to fit, as seen at *b*, Fig. 3. Thus we see that the main "sheath" is not a proper term for this part of the apparatus, for the lancets are entirely outside of it and run along the rails. The poison-gland (*P*) empties into the cylindrical part of the sheath, and keeps it constantly full of virus, at least when the bee is excited. *A*, *B*, and *C*, are broad chitinous pieces, to which muscles are attached. They form a peculiar combination of levers, too complicated in their action to be described here in detail, but they serve to thrust out the "sheath" and the lancets, giving to the former a powerful thrust, and to the latter a movement of great rapidity.

We are now prepared to understand the operation of stinging. The two lancets (*K K*) when in position lie close against the "sheath," as already described, and their ends reach just to the point of the latter. When the insect stings, the palpi (*E E*), which are drawn away from their proper place in the figure, serve to direct the organ to the most vulnerable point of attack. Then, with a sudden, powerful motion, the "sheath" is forced out and produces the puncture, penetrating as far as the point *d*, where the expansion begins. Instantly the two lancets are then forced out together, increasing the depth of the wound made by the "sheath." It has generally been supposed that the lancets were the organs that made the puncture, but this is not the fact. The lancets are thrust out until the stop-valves (*p p*) strike against the shoulder *d* (Fig. 1). This closes the cylindrical part of the sheath, which is full of virus, and this virus, being under pressure either from the sudden stoppage of the free outlet by the stop-valves or the contractions of the poison-gland (*P*), or both these causes combined, makes its way into the tubular lancets through the openings already mentioned just back of the stop-valves, and enters the wound through the branch-tubes *b b b b b* (Fig. 2). Thus we see that the injection of the poison into the wound is fairly comparable to the working of an hydraulic ram.

When the honey-bee stings, it is well known that the sting is not withdrawn from the wound. The sharp barbs on the lancets make it impossible for the bee to withdraw them, but more than these may be left behind. By allowing the insect to sting a piece of soft leather, not only the lancets but also the sheath and poison-gland will be beautifully dissected out, the bee apparently not suffering from their loss.

It will be seen that the lancets are curved at their attachment with the levers which move them. This curved portion is flexible, while the points are brittle. The poison-gland is provided with a muscular coat. It has been previously supposed that the virus was expelled from the gland by the pressure of other parts. There are several interesting points connected with the mechanism of the sting, which have been

omitted here on account of the detailed description that would be required to make them intelligible.

Naturalists should not be slow to appreciate the conscientious labor which alone has led Mr. Hyatt to these results, or to follow up the line of investigation which he has opened.

REFLEX ACTION AND DISEASE.

By T. LAUDER BRUNTON, F.R.S.

AS a preliminary to the paper of this evening upon reflex action as a cause of disease and a method of cure, I must say a word about reflex action itself, and also about another subject with which it is very closely connected, viz., the transference of impressions.

Reflex action is the effect produced by an impression made upon a sensory nerve, transmitted by that nerve to a nerve-center, and reflected or thrown back along a motor nerve in much the same way as we may imagine the force to be which is applied to one end of a string running over a pulley and transmitted in a different direction by the other end to produce a certain effect. If we fancy the farther end of the string to be divided into several strands, each of which is attached to a different object, and which may be, separately or together, affected by a pull on the nearer end of the string, we shall form a still more definite notion of reflex action, for an impression made upon the same sensory nerve may produce various results, according to the strength of the impression and the efferent nerve-channel along which it is thrown back by the nerve-center. An impression made upon a sensory nerve, for example, may produce motion of either a voluntary or involuntary muscle, or may affect the nutrition of a tissue. Under the head of involuntary muscles we must class the muscular fibers of the vessels, and those vascular changes which in themselves play a great part in nutrition and secretion may be very greatly influenced by impressions made upon sensory nerves. The way in which we know that the nutrition of a tissue may be influenced reflexly apart from the changes in the vessels is, that observations on the submaxillary gland have demonstrated that we may, under certain conditions, obtain vascular changes without the secretion which usually accompanies them, and that, *vice versa*, we may obtain secretion without the vascular changes which ordinarily accompany it. Thus, on stimulating the nerves of the tongue, the impression which we make is usually transmitted by the fifth nerve to the brain, and is thence reflected down the chorda tympani to the submaxillary gland. There it induces dilatation of the vessels, and free secretion of saliva from the gland. But if we administer atropia we do away with one of these

[1] Read before the Abernethian Society, St. Bartholomew's Hospital.

results, while we leave the other as it was—we completely arrest the secretion, but we allow the vessels to dilate as before. If, on the other hand, we employ physostigma, we contract the vessels, but cause great secretion, such secretion as is usually accompanied by dilated vessels and the free flow of blood through the gland. It is evident, then, that vascular changes, although usually associated with alterations in nutrition, do not necessarily cause them; and that, in the gland we have just mentioned, changes in the tissues composing it will occur without the caliber of the vessels or the flow of blood through them undergoing any material alteration.

We will now say a word about the transference of impressions. Just as we may imagine the farther side of the cord passed over the pulley to be divided into different strands, while the nearer side is single, and as we imagine different results obtained by pulling upon the single string by reason of those subdivisions at its farther end, so we may have the nearer end of the cord subdivided into strands, while the farther end is single, and thus we can obtain a similar result by pulling any one of the strands on the nearer end. This simile may serve to illustrate the way in which we may obtain a similar result by irritation of various efferent nerves, the stimulation being conveyed to the nerve-center and reflected down the same efferent nerve in each case. For example, a small grain of sand in the eye will cause a person to wink violently and involuntarily. In this case the impression made upon the sensory nerves of the conjunctiva is transmitted up to the brain, and reflected down the motor nerves of the orbicularis palpebrarum. But some time ago, after the extraction of a tooth, and while the wound in the gum was healing, I observed a twitching in the corresponding eyelid somewhat resembling that which would have been caused by a grain of sand in the eye. Here, also, we have the motor nerves of the orbicularis reflexly excited, but the strand, if we may so term it, through which the stimulus was sent up the nerve-center was not the same, for in this case it was a dental and in the other case an ophthalmic branch of the fifth. With these general remarks on reflex action and transference of impressions, we will now proceed to consider some cases in which reflex action is a cause of disease. I have just mentioned one instance in which intermittent spasm of a voluntary muscle, the orbicularis palpebrarum, was caused by irritation of a sensory nerve. This leads me to remark that a very important condition to be borne in mind is that constant stimulation of a sensory nerve will often produce clonic or intermittent, and not tonic or continuous, contraction of the muscles which it may set in action. It was observed by Nothnagel that if the sciatic nerve of a frog's leg was subjected to constant stimulation under certain conditions, the contractions which it induced reflexly in the other leg were intermittent or spasmodic, but not continuous or tetanic. Another instance in which voluntary muscles are reflexly affected is seen in the acts of coughing and vomiting.

Coughing is adapted for the purpose of expelling irritating substances from the respiratory passages, and thus preventing their injuring the organism, just as the act of winking is adapted to remove injurious substances from the eye. Coughing is usually excited by irritation of the nerves of that part of the body from which the irritant is to be removed. But coughing, like winking, may be reflexly induced by other nerves than those which usually excite it, and thus may prove hurtful instead of useful. Thus, in pleurisy, irritation of the pleura causes the same expulsive efforts as a foreign substance in the bronchi, although those efforts can expel nothing, and only cause pain to the patient; and even when the act of coughing is induced from the ordinary nervous channels, but where the irritant, like tubercle in the lungs, can not be removed, the act is likewise injurious. In the same way, vomiting is most frequently induced by the presence of irritating substances in the stomach, and proves useful by causing their rejection and thus relieving the stomach of their obnoxious presence. But when the irritation is due to inflammation of the walls of the stomach itself, the expulsive efforts of retching are quite useless, and only exhaust the patient. Here, too, the act of vomiting can be induced by irritation of other nerves than those of the stomach itself. Irritation of the pharyngeal branches of the glosso-pharyngeal and of the pulmonary branches of the vagus, irritation of the hepatic nerves by the passage of a biliary calculus, irritation of the renal nerves by a calculus resting in the kidney or passing down the urethra, irritation of the intestinal nerves (as, for instance, by incarceration of a hernia), irritation of the uterine nerves by the presence of a fœtus in the womb, or of the ovarian and vesical nerves by inflammation of the ovaries or bladder, may all produce vomiting; and in all, or nearly all, these cases, efforts at emesis will be productive of no beneficial result. When the irritation is further down the intestine, as when an ulcer is situated in the rectum, there is a constant desire to go to stool, but the only results of the expulsive efforts involved in its gratification are exhaustion of the patient and aggravation of the ulcerated condition. In the efforts of micturition, as in those of vomiting and defecation, we have combined movements of voluntary and involuntary muscles. The urine is retained in the bladder by the contraction of the sphincter surrounding its neck, and it is expelled by contraction of the body of the bladder itself with the assistance of the abdominal muscles. Both the sphincter of the neck of the bladder and the muscular walls of the organ itself may be reflexly excited to contraction, and we may thus have reflex incontinence or reflex retention. One of the most common causes of incontinence of urine, for example, is the presence of ascarides in the rectum; and while the ascarides remain we may employ drugs to cure the incontinence without success. An interesting case is described by Mr. Teevan in the "Practitioner" for October, 1876, where a boy had been treated in vain by medicine, but was at once cured by healing a fistula

in ano from which he had been suffering, the irritation produced by it appearing to have been the real cause of the incontinence.

We will now pass from reflex changes in the respiratory and intestinal tracts to reflex changes in the blood-vessels and heart. It is well known that, usually, irritation of a sensory nerve causes dilatation of the vessels in the part supplied by that nerve, and contraction of the vessels in the other parts of the body. This may take place without any alteration whatever in the beats of the heart itself; but if the irritation be very strong, or applied to certain nerves, the heart also may be acted upon. There seem to be certain nerves which act more readily upon the heart than others, and more especially is this power possessed by the fifth nerve, the roots of which are very closely associated with those of the vagus. On stimulation of the branches of the fifth nerve passing to the nose in animals—as, for example, by holding ammonia, strong acetic acid, or chloroform before the nose of a rabbit—the beats of the heart may be suddenly and completely arrested. To a similar arrest of the cardiac pulsations by irritation of the dental branches of the fifth, I attribute the numerous deaths which have occurred through the extraction of teeth under chloroform. It is probable that the extraction of teeth would, under all circumstances, be an exceedingly dangerous operation, were it not that in the waking condition irritation of the dental nerves sets in motion two pieces of mechanism, one of which, to a great extent, counteracts the effects of the other. As I have already mentioned in a former paper, I was once asked how it was that the application of ammonia or acetic acid to the nose of a fainting person was proved by experience to be beneficial, when theoretically it ought to be injurious by arresting the already enfeebled heart. The answer to this is, that ammonia or acetic acid, held before the nose of a fainting person, by irritating the branches of the fifth nerve, does not act upon the heart alone—it causes contraction of all the vessels of the body, and thus keeps the arterial system full, and the blood-pressure high, despite the diminished current poured into it by the flagging heart. So much is this the case, that I have found, in an animal in which the heart was weakened and the vessels dilated by shock, that the application of ammonia or acetic acid to the nose raised the pressure by one fourth of the whole. In the ordinary waking condition, the sudden stimulus of extracting the tooth has its effect upon the heart completely counteracted by the coincident contraction of the arterioles throughout the body which it also causes. In chloroform narcosis, however, these two reflexes are not influenced equally by the drug, and the reflex upon the heart may remain after the reflex action upon the vessels has been abolished, so that the heart may stop, and death will then ensue; for, the capillaries being no longer contracted, the blood at once drains out of the arteries into the veins, and circulation ceases. Another very important reflex upon the heart is that which is effected through the solar plexus and the sym-

pathetic nerve. A stroke upon the belly will through these nerves stop the heart, dilate the vessels, and induce the most serious conditions of shock, killing the patient, or at any rate bringing him down to death's door. The most important nerves through which the vessels are reflexly contracted are the splanchnics, and the contraction of the abdominal vessels which they supply has much more effect in altering the general pressure of blood throughout the arterial system than the contraction of any other vascular district in the body. But although the abdominal vessels are the chief ones concerned in alterations of blood-pressure, yet local alterations in the various organs may have an even more powerful action upon the nutrition of these organs themselves; for it is probable that although the abdominal vessels may be caused to contract by powerful stimulation of almost any sensory nerve, yet that the blood-vessels in different organs of the body—such as, for example, the kidneys or mucous membranes—are more affected by irritation of some nerves than of others. The researches of Sanders-Ezn have shown that stimulation of certain sensory nerves, or of limited districts of the skin, will induce definite muscular action due to contraction of limited groups of muscles. It is probable that irritation of limited districts of the skin also induces contraction of limited groups of involuntary muscular fibers or of limited districts of vessels. It is well known that tonsillitis is much more frequently produced by exposure to a draught which strikes the back or side of the head than by a current of air meeting one full in the face, or even by long-continued exposure to a storm in the open air. The cause of this has not yet been satisfactorily ascertained, but it has been attributed with some probability to irritation of the nerves of the ear by the cold current of air. When the throat is irritated, the irritation is not unfrequently felt in the ear; and, *vice versa*, it seems probable that irritation in the ear may cause alterations in the throat. It has been observed that pressure upon the floor of the external auditory meatus in a person who had suffered from otorrhœa produced violent or uncontrollable coughing; and, if irritation of the ear thus produces a motor reflex like that of irritation of the larynx, it seems probable that it may also produce a reflex trophic disturbance similar to that which would have followed the direct application of an irritant to the larynx.

Congestion of the kidneys in horses is caused by exposure of the loins to rain, the action of cold upon that district of the general surface having a peculiar effect upon the kidneys, not produced by its application to other parts of the body. It is stated by Sidney Ringer, upon Brown-Séquard's authority, that blistering the loins will cause contraction of the vessels of the kidney, but I have not been able to verify this quotation. But, though there seems to be a peculiar relation between the loins and the kidney, the renal circulation would appear to be affected by other nerves. Thus, for example, in a case narrated by Dr. Griffith at a meeting of the Medical Society of London, albu-

minuria was produced by the application of a dressing to an anal fistula, which ceased when the dressing was removed, and again appeared on its reapplication. In this case the vessels of the kidney seem to have been reflexly affected by the irritation applied to the anal nerves to such an extent as to produce albuminuria, although probably no organic disease of the kidneys themselves was present. Exposure of the abdominal walls to rapid changes in temperature may bring on diarrhœa, as the natives of India well know. It is possible that in these instances the cold acts through the abdominal walls upon the intestines themselves; but it seems also highly probable that some part at least of the action is reflex from the surface of the abdomen. Whatever the cause of it may be, however, it may be guarded against by wearing a *cummerbund*, like the Hindoos; and it is well for persons who are subject to diarrhœa to wear, even in this country, a warm woolen or silken belt around the abdomen.

Irritation in the intestines may induce, not merely vomiting and diarrhœa, but even general convulsions; and cases are on record of epileptic fits having been produced by the presence of a tapeworm in the intestine, which ceased upon the expulsion of the intruder. Hysterical fits, although their pathology is far from being understood, are now becoming to some extent associated with ovarian irritation; for it is found that, in many cases of hysteria, the ovaries are tender upon pressure, and that the hysterical fit may frequently be instantaneously arrested by pressing upon the ovaries.

We have so far been dealing chiefly with reflex action as a cause of disease, but now we must say a word or two respecting the transference of impressions. It is well known that persons who have had their legs amputated often complain of cold feet, or of pains in their toes, on change of weather. The irritation here is really in the end of the divided nerve in the stump. But the brain is accustomed to refer all impressions made upon a nerve during its course to the terminal filaments from which impressions usually come, just as we feel a tingling in the fingers when we pull upon or jar the ulnar nerve, or, as it is popularly termed, the funny-bone. In disease of the hip, the irritation is felt, not so much in the hip.itself, as in the knee.

In headaches one can frequently trace the origin of the pain to some point at a distance from the aching part. Some years ago I met with a case which was to me very instructive. A woman complained of a headache situated in the left temple. One of her teeth at the same time ached somewhat, and I gave her a pledget of cotton-wool, dipped in solid carbolic acid, to put into the cavity. To my disappointment it had little or no effect; but five minutes afterward, on the removal of the cotton-wool to the cavity of a second tooth, likewise decayed, but which had not at first been suspected as the cause of the mischief, the pain disappeared entirely from the temple. Some time afterward I was led to discover an unsuspected decayed spot in one of

my own teeth by a headache in the temporal region. I had noticed that during these headaches there was generally tenderness over the aching part, and that there was also a tender point at some little distance, usually the eye, which was tender to pressure. On this particular occasion, however, there was no tenderness of the eye, and I felt all along the side of the cheek and under the jaw to see if I could discover a second tender spot. Under the ramus of the jaw I found a small gland painful on pressure. As glandular irritation almost always indicates something wrong in the lymphatics which pass to the gland, I at once suspected something in the mouth to be the cause of the tenderness. As there was no abrasion or tenderness of the mucous membrane of the mouth or tongue, I took a pointed instrument and tested each tooth successively. At the very back of the crown of the last molar I detected a small point which was tender upon pressure, and on going to a dentist I was informed that the point was just beginning to decay. Had it not been for the headache this would have passed unnoticed, as the tooth itself had, up to that period, given me no inconvenience whatever. Headache over the eyes, although frequently depending on gastric irritation, is not unfrequently caused by straining the eyes, and is only to be removed by lessening the work which these useful organs have to perform. One finds this headache over the eyes in men who work much with the microscope, or in women who are engaged in fine needlework. Yesterday I met a case of this sort in the surgery. This was a woman who had been accustomed to work about her house, but who began to work at dressmaking three months ago; her hours of work being from 9 A. M. to 9 P. M., with an interval of an hour for dinner in the middle of the day. About two months ago she began to suffer from headache above her eyes, which makes her sometimes feel quite giddy. It gets worse in the evening about seven or eight. The headache here, it will be observed, came on about a month after the eyes had been subjected to this unaccustomed strain; and it became worse in the evening after the darkness rendered artificial light necessary, and thus increased the visual strain.

Having said so much on reflex action as a cause of disease, we will now consider it as a method of cure; and the first instance that suggests itself to our minds is the beneficial effect of a blister. Two theories have been proposed to account for the action of a blister. One is, that it dilates the vessels of the skin in the part to which it is applied, and, by thus drawing away some of the blood from the inflamed organ below, lessens the pain and inflammation in it. The other theory is, that the blister acts reflexly upon the organ itself. The first of these suppositions is very improbable, because the amount of blood in the skin covered by a blister is exceedingly small, and, moreover, does not come from the inflamed organ, with which the blistered piece of skin may have little or no vascular action. The second theory is much the more probable one, but it is not yet certain how the vessels of the

inflamed organ are affected by the blister. We do not know whether they are dilated or contracted. It is most likely, however, that they are contracted, the contraction lessening the pressure of blood upon the inflamed tissues, and thus diminishing the pain in somewhat the same way as we relieve the throbbing in an inflamed finger by holding the hand above the head, or by compressing the brachial artery. This is rendered probable by the experiments of Zülzer, who found that when a blister was applied to the back of a rabbit for a length of time the skin and the muscles immediately below it were red and congested, but the deeper layers of the muscles, the pleura, and even the lung on the same side, were pale and anæmic. There are few inflammations of the internal organs in which blisters to the surface are not serviceable, but much has yet to be done to ascertain the exact points at which they ought to be applied in order to produce their maximum effect. Thus it is said that in sciatica a blister to the heel will sometimes afford relief, while one applied in the neighborhood of the nerve itself has little or no effect.

The effect of poultices is probably different from that of blisters, although ultimately productive of similar relief; for, if we again take the simple instance of a finger inflamed in consequence of a thorn having run into it, we find that we can relieve the pain in two ways, either by putting the hand into cold water or by plunging the finger into a warm poultice. Both of these measures, apparently so dissimilar, will produce a like result in regard to the inflamed point; that is, both will lessen the pressure of blood in the vessels where stasis has already taken place. The cold, applied to the whole of the hand, will cause the arteries leading to the finger to contract, and will thus diminish the supply of blood to the inflamed part, and lessen the pressure in the blocked capillaries. The warm poultice will also lessen the pressure, not by diminishing the flow of blood to the part, but by dilating the vessels around the point of stasis, and affording the blood a ready exit into the veins. In the case of internal organs, the blister applied to the skin probably acts like the cold applied to the finger, while the warm poultice placed upon the surface of the thorax or abdomen affects the deeper lying organs in the same way as it does the superficial ones, the warmth penetrating through the thin thoracic or abdominal parietes. On this account, when we wish to relieve pain in the chest or belly, we ought to make our poultices in a particular way. The common practice of mixing the linseed-meal with hot water, and applying it directly to the skin, is quite wrong, because if we do not wish to burn the patient we must wait until a great portion of the heat has been lost. The proper method is to take a flannel bag (the size of the poultice required), to fill this with the linseed poultice as hot as it can possibly be made, and to put between this and the skin a second piece of flannel, so that there shall be at least two thicknesses of flannel between the skin and the poultice itself. Above the poultice should be

placed more flannel, or a piece of cotton-wool, to prevent it from getting cold. By this method we are able to apply the linseed-meal boiling hot without burning the patient, and the heat, gradually diffusing through the flannel, affords a grateful sense of relief which can not be obtained by other means. There are few ways in which such marked relief is given to abdominal pain as by the application of a poultice in this manner.

Besides blisters and poultices, there is a third class of remedies acting reflexly, which is often too much neglected or despised, but is of exceeding service; I mean plasters. In chronic bronchitis, a plaster on the chest affords great relief, the plaster employed being either the simple pitch one, or the *emplastrum calefaciens* of the British Pharmacopœia. The pain in the chest just under the mamma, which is so often associated with anæmia and leucorrhœa, is relieved in the most remarkable way by the application of a belladonna-plaster, and the same application also relieves when the pain is dependent on organic disease of the heart. The pain in the back, also, which is associated with leucorrhœa and uterine disturbances, is greatly eased by the application of a pitch plaster, or by a strip of *emplastrum calefaciens* placed along the lower part of the spine. In place of this, the *linimentum sinapis*, put upon a piece of spongio-piline four or five inches broad and ten or twelve inches long, has recently been recommended by Dr. Gamgee. The cause of the pain in the back is not known, but Dr. Gamgee's theory is that it is due to exhaustion of the lumbar portion of the spinal cord, that part from which the nerves for the urinary and genital organs are derived. In order to repair this exhaustion, he thinks that the supply of blood should be diminished, because functional activity is usually associated with rapid circulation, while the opposite condition of partial anæmia occurs during the period of rest and repair. To obtain this partial anæmia he employs counter-irritation, differing from that of the blister in being less intense and more prolonged.

Such are a few of the more prominent instances of reflex action, as a cause of disease and a means of cure. To enter fully into all of them would occupy more time than the Society can afford, and to explain them satisfactorily would require more knowledge than I either possess or am able to obtain.—*Brain.*

IS CONSCIENCE PRIMITIVE?

By WARRING WILKINSON.

MR. DUGDALE, in his recent monograph, "The Jukes," has endeavored to show by rather startling statistics how crime and pauperism become hereditary. In this vicious and depraved family, there is a conspicuous absence of moral sensibility—a lack of what we call conscience—that strikes the social scientist as something abnor-

mal. Is not this lack rather a return to normal conditions by the removal of that favorable environment which holds in check the lower instincts, and helps to develop the higher capabilities, of man's nature? Is not that juvenile monstrosity Pomeroy a sort of moral atavism? In short, did the primitive man have a conscience?

And, lest the mere question should shock some good people, let it be premised that the foundations of the Christian religion do not rest upon a belief or disbelief in an innate conscience any more than the popular fallacy of an innate and universal idea of God is a necessary tenet of orthodox faith. These theories form no essential part of religion. They are simply some of the outposts which theologians and schoolmen have erected to strengthen, as they imagine, the citadel of Biblical truth, but forming no part of the citadel itself. These needless defenses have been multiplied in the course of centuries till the thing defended has sometimes been lost sight of. The Fathers have usurped the authority of the Apostles; ancient interpretation ranks revelation. Milton has come to substitute Moses to that degree that so learned a man as Professor Huxley has considered it worth his while to apply the tests of a scientist to the visions of a poet. It must be confessed that time and tradition have lent a sanctity to many articles of popular creed that have little authority in Holy Writ, and the so-called conflict between Science and Religion will have served no ill purpose if in its heat the rubbish of ages is burned away. In this conflict man's fictions may suffer—God's truth, *never*.

In the language of theology the conscience is a separate and distinct faculty of the mind—a sort of Supreme Court to which all cases involving the principles of right and wrong are immediately referred for adjudication and intuitively settled. It is generally asserted that this faculty is congenital—chief justice by birth and divine right. I believe, on the contrary, that this mind faculty is not innate, but, if it exists at all, it is born of the other faculties, is educated to its functions, and, like the late Electoral Commission, reflects its training in all its decisions.

A conscience to justify the popular notions of its origin and authority ought to be infallible, and must be *universal*. If this faculty is an innate and essential part of man's being, it should be in every man, and exercise its functions everywhere. It is admitted that isolated and sporadic cases of deficient moral sensibility do not authorize the logical conclusion that there is no such thing as conscience, any more than the inmates of a blind-school prove that there is no such thing as sight; but if there are found whole tribes of people who not only lack all evidence of a conscience, but whose language has no words to express moral distinctions or ideas of right and wrong; if, in addition, we find that where higher races give evidence in language and life that they have certain moral perceptions, yet that the decisions of conscience always follow local tradition and custom—it seems a fair

inference that the faculty itself is not an essential of man's mental constitution, but is a product of culture; the resultant perhaps originally of observation and experience, which in time, and under the influences of civilization, *may* become an hereditary aptitude, though the facts of deaf-mutism, to which reference is made hereafter, militate against the theory of transmission.

Cœlum non animum mutant qui trans mare currunt[1] is perhaps true of those who are old enough to travel, and who find national habitudes of thought and culture following them everywhere, but morals certainly change with almost every clime and age. In a broad survey of the history of morals one comes to doubt whether there is such a thing as abstract right and wrong. Every article of the religious code in which we have been educated, and which we revere, has been or is violated without remorse among the peoples who sit in darkness, but who are supposed to have that intuitive faculty which makes the pagan a law unto himself. The vice of to-day is the virtue of yesterday: a disgrace in England is a dignity in Ashantee. The crowning glory and triumph of Christian grace is the shame of the red-man's creed. Crimes against life, crimes against liberty, crimes against personal rights, crimes against chastity, crimes against nature, have all been sanctioned and justified by this infallible judge. The bitterest wars have been religious wars, where the contending hosts were stimulated and led on by conscience. The fiercest persecutions have been religious persecutions, where conscience stretched the rack and tightened the thumb-screws. The blood of martyrs stains the skirts of every sect: Catholics have persecuted Protestants, Protestants have persecuted Papists, and both have set their heel upon the Jew. The atrocities of Alva were equaled by the cruelties of Louvois. The victims of St. Bartholomew find a parallel in the sufferings of the Scotch Covenanters. Saul thought he was doing God service in haling men and women to prison and to death. Blood for blood is Hebrew as well as Indian law. The sin of stealing among the Spartans was in being caught at it. The severe Cato thought it right to yield his wife to his friend. Socrates sanctioned the prostitution of Aspasia by his daily intercourse and friendship. In the Balearic Isles a bride was the common property of all the wedding-guests before she could be the wife of one. Among the Naudowossies the woman who could take to her bosom forty stalwart warriors of a night was regarded almost with veneration, and had her pick of the tribe for a husband. Galbraith says that among the Sioux theft, arson, rape, and murder, are regarded as means of distinction. In Tahiti, while idolatry prevailed, the common animal instinct of maternal affection seemed lacking, so much so that Mr. Ellis, long resident there, says he never met a Tahitian mother who had not imbrued her hands in the blood of her offspring. It is not necessary to show that these crimes were ever considered *right*. It

[1] They change their sky, not their affections, who cross the sea.

suffices that they were committed without remorse, without a feeling of wrong-doing. They are not instances of perverted conscience, but of no conscience, and the concurrent testimony of travelers is that the lower races have no moral sense. Mr. Dove says that the Tasmanians "are entirely without moral views" or impressions. Governor Eyre says the Australians have no moral sense of what is just and equitable in the abstract, their only test of propriety being whether they are numerically or physically strong enough to brave the vengeance of those whom they may have provoked or injured. "Conscience," says Burton, "does not exist in eastern Africa, and 'repentance' means regret for missed opportunities of mortal crime." Mr. Campbell observes that the Soors, an aboriginal tribe of India, are without moral sense. Language is a pretty good measure of mental development, yet the dialects of inferior tribes are generally deficient in terms expressive of moral quality. Remorse is absolutely unknown, and Lubbock says the only instance of a man belonging to one of the lower races trying to account for an act is the case of a young Feejeean, who, when asked why he had killed his mother (in law?), answered, "Because it was right."

It is very difficult to get at the original man, for the reason that wherever found he is the heir of all the ages, and the training of circumstance and condition begins away beyond the reach of mind and memory. No man can remember the time when he could not talk or walk. He can not remember when sad experience first taught him that the candle-flame was not just the thing to cut his teeth upon. No more does his memory go back to the time when his first lessons in ethics were enforced by the gentle spat of the mother's hand or the warning "No! no!" of her reproving voice. Humanity forbids repeating the cruel experiment of Psammeticus, who secluded a child from all intercourse with his kind in order to get at the original speech of man. But nature has done what civilization would have no right to do, and offers in the phenomena of deaf-mutism a psychological study of curious interest. Considered from an intellectual and moral standpoint, the deaf-mute is an anachronism—a prehistoric man standing bewildered in the blaze of the nineteenth century. By simple severance of a nerve connection an invisible barrier is thrown around the child, and in this seclusion the mind develops to a certain extent free from the influences of accumulated culture, and is in respect to ethical notions absolutely primitive. The animal instincts are strong, and their gratification sought after the manner of an animal. He appreciates kindness and resents injury. He will steal and hide the thing stolen, but I have seen a dog do the same. He acquires certain ideas concerning the rights of possession, and will commit murder in defense of such right without remorse. In a recorded case near Rodez, France, officers were sent to seize property for debt. They were driving off the peasant's cow, when the farmer's son, an uneducated deaf-mute, seized a club

and brained the officer, and when brought into court could hardly be restrained from inflicting the same punishment upon the constable's assistants whom he recognized there. He was acquitted, on the ground that, being entirely ignorant of the legal rights of the case, he had only obeyed one of the first laws of nature in defending his father and his property.

The uneducated deaf-mute never rises to the conception of a God or Great First Cause. If he reasons at all on the subject, he concludes things have always been as they are, or as one expressed it, "it was natural to be so." He has no idea of a life beyond the grave, nor of future rewards and punishments. The more intelligent will work out philosophies not of creation but of physical phenomena, sometimes strangely like the mythologies of the ancients, and the similarity of these myths indicates how naturally the primitive mind materializes and seeks explanation of phenomena by the generalizations of personal experience. The association of causes is sometimes ludicrous.

An English deaf-mute boy observing that he could raise quite a strong wind with his mother's bellows, naturally concluded that the wind which sometimes took his hat off in the street came from the mouth of a gigantic bellows. He never stopped to inquire who blew the bellows. A little girl imagined that the plants which spring up from year to year in the fields and woods were like those in her mother's garden, planted and watered by "some woman"—an infantile conception, in which, however, may be traced a kindred germ to the old Greek notions respecting nymphs and dryads. One lad, struck by the similarity between flour falling from a mill and snow falling from the clouds, concluded that snow was ground out of a mill in the sky. A more poetical notion was that of a little fellow who thought the soft, feathery snow-flakes in the winter were the falling blossoms of unknown orchards in the sky, of which hailstones in summer were the icy fruit. Some suppose thunder and lightning to be the discharge of firearms in the sky, a notion the converse of that of the Aztecs, who believed the Spaniards were gods armed with thunder and lightning.

Thus it is that human nature repeats itself, and that deaf-mute children left, by their inability to profit by the experience of their elders, in a prolonged infancy exemplify, in their efforts to account for the phenomena of nature, many of the fancies that prevailed in the infancy of society.

But if this primitive mind fails to grasp the idea of a Great First Cause, it is equally clear that ethical distinctions are also lacking; and this belief is supported by good authority among those who have intimate acquaintance with this peculiar class. Abbé Sicard says of the deaf-mute: "As to morals, he does not suspect their existence. The moral world has no being for him, and virtues and vices are without reality." "The deaf and dumb," says Herr Eschke, of Berlin, an eminent teacher, "live only for themselves. They acknowledge no social bond, they

have no notion of virtue. Whatever they may do, we can impute their conduct to them neither for good nor for evil." Herr Cæsar, of Leipsic, corroborates this testimony. "The deaf and dumb," says he, "comprehend neither law nor duty, neither justice nor injustice, neither good nor evil; virtue and vice are to them as if they were not."

The proof of this moral deficiency by deaf-mute testimony is not so easily obtained, for the reason that the deaf-mute early learns by parental discipline to attach certain consequences to certain acts, and, when he becomes educated enough to be questioned concerning moral perceptions, he has forgotten the time when he did not have what he calls conscience, but which is no more like the theological definition of conscience than is the feeling that makes a dog slink away when detected in wrong-doing. I am not prepared to say that animals have no conscience; indeed, I am quite sure they have the same kind of inward monitor that an uneducated deaf-mute has: child and pup are alike restrained by severe tones and a switch, only the pup learns the most readily. You can teach a hungry dog to watch a piece of meat quicker than a child can be brought to resist the temptation of stealing cherries. Both respond to the gentle culture of caress and kindness, though the dog is the more boisterous in his acknowledgments. Indeed, every parent who has watched the development of an infant must have noticed how like the means used in training animals is the method of child-education. There are the same warning tones, the thwarting of desires, the resort to punishment, and the smiling face, the nod of assent, the rewards of well-doing, and the petting of approbation. With the child there is much iteration of reference to right and wrong; but it is the rewards and punishments which he understands, and not the wordy appeal to the higher motives.

That this is true of the uneducated deaf-mute naturally follows from his peculiar symbols of thought. He thinks in images, and the signs he makes grow out of and represent these images. His ideas are concrete, in the sense that he seldom arrives at general conclusions, his judgment being exercised on particular cases that have fallen under his observation, and which he recognizes when they occur again. Morality is an abstraction that goes beyond the reach of his instruments of thought, and it is only as he comes within the larger capacities of the sign-language as developed and used in institution-life that he can be brought to the level of spiritual conceptions, and to do this we have continually to make stepping-stones as it were out of his own crude and imperfect mental imagery. In this respect the deaf-mute does not differ from the many lower races whose language is so wanting in expressions for spiritual truths that missionaries are obliged to use the most material words from the meager vocabularies of the savages to express their novel messages of mercy and peace.

That what we call the dictate of conscience is only another name for an act of judgment and reason, seems evident from the difficulty one

has in deciding as to what is right and what is wrong. A lawyer may have pronounced upon certain common points of law so frequently that when a case is presented he does not stop to think, but gives answer immediately, yet one would not say that he acts intuitively. So in what might be called the grosser matters of morals the judgment is able to act quickly from frequent exercise, but, when it comes to the nicer distinctions of ethics, so far from acting intuitively or quickly, the mind is often in long and painful doubt. To tell the truth seems to be a plain duty, yet who would dare to condemn Sister Surplice's lie in defense of poor Jean Valjean? "Thou shalt not steal" is human and divine law, but shall a man starve rather than take a loaf of bread that does not belong to him? When does manslaughter in self-defense become justifiable? The relative duties to God, to self, and society, to family and friendship, require much weighing of motive, and evidence, and interests, which, so far from being settled intuitively, call for the most careful exercise of judgment.

The limits of time and space forbid a further discussion of this subject beyond the following summary of conclusions:

1. That examination of minds nearest to primitive conditions shows that there is an utter absence of moral feeling, and that therefore conscience is not a congenital faculty.

2. That the idea of duty is an abstraction, which comes with considerable development of mind and a power of generalization of which the lower races are not capable.

3. That what is called "conscience" is simply an act of judgment and reason.

4. That the decisions of conscience depend upon the education of the individual; and—

5. That therefore conscience, even among intellectually developed races, is not an infallible guide, but must itself be guided by a written law.

FIRES AND THEIR CAUSES.

THE oft-repeated words, "Cause unknown," appended to the daily reports of the conflagrations which occur all over the country, furnish matter for grave reflection. A glance at the report of one of the largest fire brigades will show us that the causes (when ascertained) are of the most varied description. It appears that the candle is the most destructive weapon to be found in an ordinary household, for conflagrations lighted by its help far outnumber those credited to any other cause. Curtains come next on the black list. The next large figures are given to "Spark from fire," followed by "Foul flues." Next in order may be noticed "Gas," "Children playing with fire,"

"Tobacco-smoking," "Spontaneous ignition," and lastly "Incendiarism."

There is no doubt that many a fire owes its origin to causes quite beyond the control of the tenant of the house in which it occurs, and that the scamping manner in which builders' work is often done is the prime cause of many a fire which is put down as unaccounted for. The ends of joists are left protruding into chimneys, or a thin hearthstone is set upon a bed of timber. In both cases the wood becomes so dry and hot that it is ready to take fire from the first spark that settles near it. Overheated flues represent a source of danger which is also attributable to the careless builder; for, if the flue were so placed that its hear could not affect adjacent woodwork, it would be always as safe when hot as when cold. It is true that by act of Parliament builders are obliged to preserve a certain distance between flues and timber; but surveyors can not always reckon on their instructions being carried out, and cases are unfortunately rare nowadays where workmen will do their duty in such matters without constant supervision. Lath-and-plaster divisions between houses are also illegal; but buildings, and more especially warehouses, are now of such vast extent that they really represent aggregations of small houses in which the act of Parliament concerning party-walls becomes a dead-letter.

Among the ascertained causes of fire are those which occur in the various workshops where hazardous trades are carried on. These naturally show an increase since steam-power has become such a universal aid to nearly every kind of human labor; necessitating furnaces which remain kindled for weeks or months together. Apart from this source of risk, there are numerous trades where such inflammables as turpentine, naphtha, spirits of wine, and combinations of them in the form of varnishes, are in daily use to a very large extent. The familiarity which such constant use provokes breeds a contempt which often resolves itself into a negligence almost criminal in its nature. Drying-stoves afford another dangerous item in the list of fires connected with the trades; japanners, cabinet-makers, and hosts of others using such stoves as a necessity of their business. Hot-water pipes for heating purposes also represent the cause of a large number of fires, the most dangerous kind being those which are charged with water and hermetically sealed. The reason of this is easily explained. Water boils at a temperature far below that necessary to ignite woodwork; but, when confined in such pipes as we have described, it will rise in temperature to an extent only measured by the strength of the material which holds it. A soft metal plug is sometimes inserted in these pipes, so that, should any unusual degree of heat be approached, it will melt out, and thus relieve the pressure; but such a good precaution is by no means universal.

The pipes which are used for carrying off heated air, and which are placed above gas-burners, are too often allowed to pass between the ceiling and the floor above without any regard to the obvious danger in-

curred. The various close stoves which were introduced to public notice at the time when the price of coal was suddenly doubled, although no doubt economical, are not so safe as the old form of kitchen range, which many a careful housewife has likened to a cavern. The whole of the air which rises through the flue of a closed stove actually passes through the fire, and thus attains a very exalted temperature. In the old stoves, on the other hand, the hot air is always largely diluted with that which is attracted to the chimney from all quarters. It is evident, therefore, that the chances of fire in the flue of the former are much greater than in that of the latter.

Theatres may be said to combine within their walls all the risks which we have as yet alluded to, for they represent factories where work of a most diversified kind is carried on, and where both open and closed fires are in constant use. At pantomime time especially, the number of persons employed in the various workshops of large theatre is to the uninitiated quite marvelous. Carpenters and "property-men" (those clever workmen who can make everything from a bunch of carrots to a parish pump) represent a constant source of danger from fire, in that they deal with inflammable material, and require the aid of heat for their size and glue. It is obviously important in a little kingdom where all is make-believe—where the most solid masonry is wood and canvas, where the greenest trees are dry as tinder, where even limpid streams are flimsy muslin, nay, where the moon itself is but a piece of oiled calico—that there should be no mistake about the reality of the precautions against accidental fire. In most theatres, rules are in force of the most stringent character, extending even to such details as clearing so many times a day the accumulated shavings from the carpenter's shops. If such a sensible law were enforced in other places besides theatres, it would be a preventive measure of very great value.

Shavings are perhaps the most dangerously inflammable things to be found about a building. A block of wood is a difficult thing to set on fire; but, when reduced to the form of shavings, a mere spark will turn it into a roaring fire. The same thing may be said in a minor degree of a lump of iron, which when reduced to filings can be burned in the flame of a common candle. It is often this difference of bulk which will decide whether a material is practically inflammable or not. Paper affords another example of the same principle: tied tightly in bundles it may smolder, while in loose sheets its inflammability is evident.

It is stated upon good authority that in one third of the number of fires which occur the cause is not ascertained. The plan long ago adopted in New York, and which has led to a sensible diminution in the number of fires there, has not, for some reason, found favor with the authorities in this country. We allude to the custom of convening a coroner's court to inquire into the origin of every fire which takes place. There is little doubt that such inquiries would educate thoughtful householders into taking precautions which might not otherwise

strike them as being at all necessary. The importance of such precautions is manifest when we learn that in London alone there are on the average three fires in every twenty-four hours. If this wholesale destruction were reported of an Eastern city, where the houses are of wood, and are sun-dried by incessant tropical heat, there would be some excuse for it. But here at home, where bricks and mortar are so common, it is certainly astonishing that fires should be so prevalent.

It would seem that it is a much easier task to set an entire house on fire than it is with deliberate intention, and with proper combustibles, to light a stove for the purpose of boiling a kettle. This latter operation is not so simple as it appears to be, as any one may prove who has not already tried his or her hand at it. In fact, an efficient or bad house-servant may be almost at once detected by the ease or difficulty with which she lights her fires. The inefficient servant will place some crumpled paper in the grate, and will throw the best part of a bundle of wood on the top of it, crowning the whole with a smothering mass of coal; and will expect the fire to burn. The good servant will, on the other hand, first clear her grate, so as to insure a good draught; she will then place the wood above the paper, crossing the sticks again and again; then the coals are put in deftly one by one, affording interstices through which the flames will love to linger; a light is applied; and the kettle will soon be singing acknowledgments of the warm ardor with which it has been wooed. Contrast this with the other picture, where double the fuel is wasted, and where smoke and dirt make their appearance in lieu of tea and toast. We venture to say that a badly managed kitchen fire, with its train of unpunctual meals, leads to more general loss of temper than all the other minor domestic troubles put together. The stove is usually the scapegoat on which the offending servant lays her incompetence (the cat clearly could establish an *alibi*); but the most perfect of ranges would not remedy the fault. The only real reason for such a state of things is the prevalence of sheer stupidity. Molly's mother was taught by Molly's grandmother to light a fire in a certain way, and Molly's descendants will, from persistence of habit, continue to light fires in that manner, be it good or evil, until the end of time. It is quite clear that the same stupidity which causes an intentional fire to fail will occasionally lead to a pyrotechnic exhibition which has been quite unlooked for. For instance, cases are not unknown where servants have used the contents of a powder-horn for coaxing an obstinate fire to burn; the loss of a finger or two generally giving them sufficient hint not to repeat the experiment.

The general use of gas has done much to reduce the number of conflagrations, for it has replaced other illuminators far more dangerous; but it has at the same time contributed a cause of accident which before its use could not exist. So long as people will insist on looking for an escape of gas with a lighted candle, so long will their rashness be rewarded with an explosion. It is not customary, where there is a doubt as to

whether a cask contains gunpowder or not, to insert a red-hot poker into the bung-hole. Yet such a proceeding would be scarcely less foolhardy than the detection of the presence of gas by means of flame. The test in both cases is most thorough, but it is too energetic in its action to be of any value but to those who wish to rise in the world too suddenly.

Drunkenness is a well-known source of burned-out dwellings, the habitual tippler being too often left to his own devices in the matter of matches and candles. The usual faculty of double vision with which an inebriated man is gifted leads to a divided claim upon the extinguisher, which naturally points to a disastrous sequel. Even sober people will be guilty of the most hazardous habits, such as novel-reading in bed with a candle placed near them on a chair; for novels, like some other graver compositions, are occasionally apt to induce slumber; and the first movement of the careless sleeper may imperil his life, as well as the lives of others who may be under the same roof with him.

The caprices of female dress have also often led to fatal accidents from fire, and crinoline skirts had in their day much to answer for. But at the present time petticoats seem to have shrunk in volume to the more moderate dimensions of an ordinary sack, so that we are not likely to hear of accidents from this particular cause until some fresh enormity is perpetrated in the name of fashion. We may mention in this connection that tungstate of soda (a cheap salt) will render muslins, etc., uninflammable. But strange to say it is not generally adopted, even on the stage, where the risks are so multiplied, because it is said to prevent the starch drying with due stiffness! We have all heard of what female courage is capable when little ones are in danger, but we hardly thought that it was equal to the task of risking precious life for the appearance of a muslin dress. We can only bow, and say—nothing.

Where fires have been traced to spontaneous combustion, it has generally been found that some kind of decomposing vegetable matter has been the active instrument in their production. Cotton-waste which has been used for cleaning oily machinery and then thrown aside in some forgotten corner, sawdust on which vegetable oil has been spilt, and hemp, have each in its turn been convicted of incendiarism. The simple remedy is, *to avoid the accumulation of lumber and rubbish in places where valuable goods and still more valuable lives are at stake.* Occasionally fires have been accidentally caused by the concentration of the sun's rays by means of a lens or of a globe of water, and opticians have for this reason to be very careful in the arrangement of their shop-windows. A case lately occurred where a fire was occasioned, it was supposed, by a carafe of water that stood on the center of a table. The sun's rays had turned it into a burnnig-glass! It is stated, with what amount of truth we can not say, that fires in tropical forests are sometimes caused by the heavy dewdrops attached to the foliage acting the part of lenses.

The advance which has been made during the last twenty years in all appliances connected with the art of extinguishing fires has done much to limit or rather localize the dangers of such catastrophes; for, whereas in the old days the lumbering "parish squirt" was the only means of defense, we have now in all large towns steam fire-engines capable of throwing an immense stream of water with force enough to reach the topmost floors of very high buildings. The aforesaid "squirt" was capable of little more than wetting the outside of contiguous buildings, with a view to prevent the spread of the original fire, which generally burned itself out. But now our engines furnish a power which will often smother a large fire in the course of half an hour or less. Moreover, our well-organized fire brigades are trained to convey the hose to the nucleus of the flames, and much heroism is shown in the carrying out of this dangerous duty.

And now for a few simple precautions.

Let some member of the family visit every portion of the house before it is shut up for the night. (While he is seeing to the safety of the fires and lights, he can also give an eye to bolts and bars, and thus fulfill another most necessary precaution.) See that there is no glimmering of light beneath the bedroom doors for any unreasonable time after the inmates have retired to rest. Insist on ascertaining the cause of any smell of burning. It may be only a piece of rag safely smoldering in a grate, but satisfy yourself upon the point without delay. Do not rake out a fire at night, but allow it to burn itself out in the grate. (We have already referred to the danger of hearthstones set upon timber.) Do not allow an unused fireplace to be closed up with a screen unless it is first ascertained that there is no collection of soot in the chimney, and no communication with any other flue from which a spark may come. Caution servants not to throw *hot* ashes into the dust-bin. Let the slightest escape of gas be remedied as soon as possible, and remember that the common form of telescope gasalier requires water at certain intervals, or it will become a source of danger. Finally, forbid all kinds of petroleum and benzoline lamps to be trimmed except by daylight. (A lamp was the initial cause of the great Chicago fire.)

Many other precautions will suggest themselves to the careful housekeeper. But, after all, the best precaution is common sense, which, however, is the least available, being the misnomer for a faculty which is far from common.—*Chambers's Journal.*

THE SUN'S LONG STREAMERS.

PROFESSOR CLEVELAND ABBE, an American astronomer and meteorologist, who had intended to observe the eclipse of the sun last July from the summit of Pike's Peak, in Colorado, more than 14,000 feet above the sea-level, fell ill after he had reached that place, and was carried down to the Lake House (elevation 10,000 feet), there to remain while the rest of his party staid to view the eclipse from the summit. Probably if he had remained with them his observations would have differed in no very marked degree from those which other astronomers made on that occasion. He would have devoted a few seconds, perhaps, to the study of the sun's corona with the naked eye. He would probably have made some telescopic, spectroscopic, or polariscopic observations during the rest of the three minutes during which the total eclipse lasted, and possibly he might have noted some feature rather more effectively and satisfactorily than most of the other observers. But under the actual circumstances he could not hope thus to take his place among the thousands of observers who have noted the phenomena of total solar eclipses. He had no optical or other instrument. Worse than all, he is near-sighted; and, though he had a pair of spectacles, it was not quite strong enough to correct his near-sightedness.

Yet Professor Abbe succeeded in making observations far exceeding in interest any which were made by the entire force of eclipse observers in 1874 and 1875, and fairly comparable in this respect with the most remarkable discoveries effected during the great eclipses of 1868, 1869, 1870, and 1871. Debarred from instrumental researches, unable to do what most observers of eclipses seem anxious to do—namely, to see everything that can be seen—he was compelled to restrict himself to precisely that line of observation which we indicated eight years ago as likely to be most instructive. He gave his whole attention to the corona, and especially to its outlying and feebler portions. Studying the phenomena with the naked eye, or at least with only spectacles to aid him, he could recognize faint luminosity which the telescope would inevitably have concealed from his view. He was not hurried; nor was he disturbed by the thought that such and such instruments must be attended to in turn while still totality lasted, with care also that in the darkness nothing should be disturbed or injured. As he said after the observations were completed, and as we pointed out in 1870, "a glance of a few seconds will no more suffice to do justice to the delicate phenomena" (of the corona) "than it would suffice to enable a naturalist to draw the distinguishing features of a new shell or insect, or would enable an artist to correctly sketch in a landscape."

Before describing what Professor Abbe actually saw, it may be well to indicate first the nature of the observations he proposed to make, and

secondly his preconceived ideas as to what he was likely to see, for otherwise the value of his observations will not be fully appreciated.

Our readers may perhaps remember that in the year 1870 a discussion took place on the question whether the glory of light seen around the sun during total eclipse belongs to the sun or not. There were those who maintained very confidently the opinion that this glory is either a purely optical phenomenon only or else is due to the passage of the solar rays through our own atmosphere all round the place of the eclipsed sun. On the other hand, there were some (ourselves among the number) who pointed out that the corona must necessarily belong to the sun, since its features could not possibly be reconciled with any other theory. The greater number of astronomers seemed, however, to form no opinion one way or the other, but to prefer to leave the matter to be decided by fresh evidence. For too many imagine that the best way of showing how greatly they value observations is by declining to investigate the full significance of observations already made.

It will be remembered that before long the new observations devised to settle a question which had been abundantly answered by observations already made proved unmistakably the solar nature of the corona. Photographs were taken during the total eclipse of December, 1870, and in greater number during that of December, 1871. On the latter occasion photographic views of the corona taken at stations far apart agreed closely together, showing that the corona could not possibly be an atmospheric phenomenon. No one could imagine that the air above Baicull, where Mr. Davis (Lord Lindsay's photographer) took his views, could by some amazing accident produce coronal features resembling those produced by the air above Ootacamund, one station being close to the seashore, the other hundreds of miles inland and some 10,000 feet above the sea-level. On the other hand, the resemblance of the several views taken at either station showed that the coronal glory could not be due to the illumination of some matter on the hither side of the moon, but far outside our own atmosphere. For the solar rays, passing athwart the lunar disk to fall upon such matter, would shift rapidly in position as the moon moved onward, so that the features seen at the beginning of total eclipse would differ markedly from those seen toward the end. Since the six pictures taken at Baicull closely resembled each other, as did the six taken at Ootacamund, so that all twelve views represented the same corona (though of course not all to the same distance from the sun), it was manifest that the corona then seen was a solar appendage. The actual distance to which the corona can be traced in these pictures corresponds to about 900,000 miles.

But the believers in an atmospheric corona were not even yet wholly satisfied. Nay, before the recent total eclipse one among them even went so far as to say that the observations and photographs of 1870 and 1871, while demonstrating the solar nature of the glory immedi-

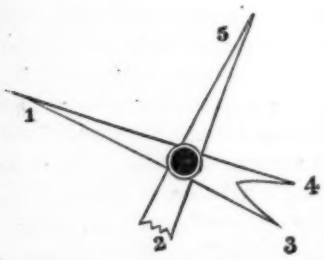
ately surrounding the sun, proved the long rays extending much farther from the sun to be non-solar phenomena. "The non-solar origin of the radial structure," said Mr. Lockyer as late as July 20th last, "was conclusively established" during the eclipse of December, 1871.

To say the truth, there is no possible way of interpreting the long rays as phenomena of our own atmosphere or of matter (gaseous, meteoric, or dust-like) on the hither side of the moon. The idea is one which mathematicians may casually have thrown out. Indeed, Mädler and Airy, after the eclipse of 1860, advanced the hypothesis that the long rays belong to matter between us and the moon, while Sir John Herschel adopted in his "Familiar Lectures" the notion that these rays belong to matter at a great height in our own atmosphere. But it would be to misrepresent these eminent astronomers to assert that they ever *maintained* these views. The available evidence, analyzed as any one of these mathematicians could have analyzed it, had he seen fit, would have shown convincingly that the rays must come from matter lying far beyond the moon. Sir John Herschel admitted this in a letter addressed to the present writer. Whether Airy or Mädler ever examined the evidence closely we do not know. If they did they doubtless were led to the same result as Sir J. Herschel. The matter may be put in this way: Since these long rays extend from the black disk of the moon during mid totality, they occupy then a part of the sky where no sun-illuminated air lies at such a time; therefore they cannot belong to our air; but if there were some very tenuous matter, aërial or dust-like, extending as far as the moon's orbit, the whole region of the sky athwart which these rays extend would contain matter of this sort under full solar illumination; no rays then would be seen, but a nearly uniform glare, which should become brighter and brighter as the distance from the sun's place increased. If we add to this that at midnight the whole of the sky, except a round spot some four or five times the diameter of the moon, would be occupied by this cis-lunar matter under direct solar illumination, instead of that illumination from behind which such matter would receive during total eclipse, we see that the darkness of our midnight sky speaks as decisively against this theory as does the brightness of the long rays seen during total eclipse.

Notwithstanding the overwhelming evidence available to show that these rays lie far beyond the moon, Professor Abbe had adopted the opinion that the rays belong to the earth's atmosphere, or else are mere optical illusions. "I had hitherto firmly believed them," he says, "to be either in the earth's atmosphere or in the observer's eyes. . . . Such rays," he adds, "were seen by members of my eclipse party at Sioux Falls City, Dakota, August, 1869; but at that time and ever since I have doubted their existence." It is manifest that he did not begin his observations with the preconceived idea that the rays belong to matter far more distant than the moon, but with a strong opinion, if not a strong prejudice, the other way.

Next let us consider the actual circumstances under which he observed the eclipse, for they also are important in enabling us to estimate the value of his result. "Having been somewhat hastily carried," he says, "from the summit of Pike's Peak down to the Lake House (elevation 10,000 feet), I had by Monday noon recovered sufficiently to be laid on the ground upon a gentle slope facing westward, where I studied the rays visible about the sun during totality. I had no optical or other instrument, and unfortunately had only a pair of spectacles not quite sufficient even to correct my near-sightedness. By straining my eyes somewhat I was, however, able to do something. My whole attention was given to the rays that extended beyond the brilliant ring which I presume represents the true solar atmosphere. I was undisturbed by any other consideration except to get a true presentation of these rays. . . . I went over the region around the sun again and again —at least six times—leisurely during the 161 seconds of totality, and cannot doubt the truthfulness and fairness of my drawing and description. . . . Two stakes were driven down on either side of me; and between them was placed a rotable axis, on which my drawing-board and paper were fastened. . . . By slightly tipping my drawing-board I kept the sun just above it, or just hidden from view, as I wished, while I drew in such details as I wished, and that too, as it seemed to me at the time, with great ease and accuracy, especially as to the angular position of the rays."

The moon or sun appeared surrounded by a narrow brilliant white ring, less than 140,000 miles broad. (We alter the technical indication of apparent breadth into the actual breadth in miles, as likely to be more intelligible to most of our readers.) This ring was as brilliant as the full moon. It was of uniform tint and light, continuous and without any break or structure visible to Professor Abbe. "Outside of this there was no other concentric coronal appearance, and no external boundary; but the immaculate blue-black sky immediately adjoined this light, which I now call the true solar corona or atmosphere." There was throughout plenty of light to read and write by, though very different from that given by the full moon.



ILLUSTRATING THE RAYS SEEN ROUND THE ECLIPSED SUN BY PROFESSOR ABBE.

The picture which accompanies Professor Abbe's description in the "Colorado Springs Daily Gazette" is doubtless not intended to present with any accuracy the actual tints or degrees of brightness of the various features observed. The shape of the streamers is shown with sufficient exactness in the accompanying figure. It will be understood, of course, that the rays numbered were seen on a dark background, the "immaculate blue" of Abbe's description.

The tapering ray marked No. 1 was the first seen by him. He says he saw it on his first glance at the corona. It then seemed to extend about three times the diameter of the sun; but in a minute or so, as the observer's eyes became accustomed to the sight, he was able to trace its tapering end to a distance of six diameters of the sun's disk. "Its sides were straight lines, its axis passing slightly below the sun's center. Its light was an exceedingly faint and delicate white, apparently overlaid or intermingled with the blue of the atmosphere. I saw no striation, texture, or variation of light. There was no decided increase of brightness in that part of the ray near the sun's edge, nor in the axis of the beam, the delicate light continuing uniform up to the corona, in whose glare it was lost." We must note here two points. In all probability the words "in a minute or so" are used in their colloquial sense for *presently*, because the whole totality did not last two minutes and a half, and in the course of that time Professor Abbe noted all the features of the corona six several times. Secondly, we find that, both in the "Daily News" and in "Nature," Professor Abbe is described as tracing the rays to a distance of six degrees from the eclipsed sun, not six diameters only; so that, as the sun's apparent diameter is little more than half a degree, these accounts would suggest that he saw the rays to double the distance described in the "Colorado Daily Gazette." But there seems little reason to doubt that the accounts given in the "Daily News" and "Nature," which constitute in reality but one account, seeing that they both came from the same source, are incorrect; for the account sent to the Colorado paper was written by Professor Abbe himself. It contains an illustration from a drawing of his own (reproduced above), which agrees with his description. Moreover, we received the paper directly from Professor Abbe; and unquestionably he would have struck out the word "diameters" and substituted "degrees" if he had really seen the ray extending to the greater distance. Note also that the word "diameter" is used throughout the descriptions of other rays.

The ray marked 2 was seen as soon as 1. Its bounding edges, diverging from each other, but not from the sun's center, produced a somewhat fan-shaped ray. "When first seen," says Abbe, "I estimated its outer limit at one diameter, but subsequently traced it to a diameter and a half from the sun. Its left-hand edge appeared somewhat sharper and brighter than the right-hand edge. With this exception the light was very uniformly distributed throughout its surface, fading away rapidly at its outer end. It also remained changeless throughout the totality."

No. 3 was also seen at the same time as No. 1. "It was narrower and shorter than No. 1: its estimated length, three diameters. It broadened at its base, like No. 1, and had the same uniform tint and intensity."

No. 4 "was not noticed at all until the totality was half over. Its

length was one diameter, and it was certainly brighter at the end farthest from the sun. It remained perfectly steady," adds Professor Abbe, "after I once noticed it, and gradually I became aware of a faint light partially connecting it with No. 3, so that the final impression left on me was that these two constituted one fan-shaped projection similar to No. 2, but fading out in the central portions. The axis of No. 1 and of Nos. 3 and 4 passed nearly, if not exactly, through the sun's center.

No. 5 extended fully five diameters from the sun's limb, "and was in all respects similar to No. 1. Its base was broader than that of No. 1, which I attributed," says Abbe, "to the glare of the increasing corona" and of a mound of the ruddy prominence matter (low-lying, so as to form only an extension of the sierra). The light of No. 5 was fainter, Professor Abbe thought, than that of No. 1. "Its edges were straight, except in so far as the coronal glare appeared to unduly broaden the base. Its axis passed very nearly through the sun's center, and was in the prolongation of the axis of No. 2."

Professor Abbe's explanation of these rays or streamers occurred to him an hour or so after seeing them. He advances it as one which "will probably result in the overthrow of all previously entertained theories respecting the character and cause of these streams of light." But in reality it is not nearly so novel as he seems to imagine. It is, indeed, partly new, and in our opinion it is in great part true; but what is true in it is not new, and we question greatly whether what is new in it can possibly be true. Let astronomers judge.

"Meteor streams," says Professor Abbe, "is the key to the solution —not such meteors as some suppose to be falling into the sun daily, but the grand streams of meteors that cause the numerous shooting stars of August and November, and of the existence of which there is indubitable proof. These streams consist of fine particles or pieces, each a long way from its neighbor, but all rushing along in parallel orbits about the sun, like the falling drops of rain in a thunder-shower. The August stream is calculated to be several hundred thousand miles broad and thick, and many million miles long. Such a stream, when far beyond the sun, but still lighted up by it, would reflect to us a faint uniform light precisely like that of these rays. If one end of the stream were farther from us than the other, the effect of the perspective would be to produce a tapering or wedge-shaped appearance. In some other part of our orbit, or with the meteor stream in some other part of its orbit, the perspective might vanish and the two ends appear of the same width. In this way we shall undoubtedly be able to explain the very numerous historical and memorable occasions on which flaming coronas, swords, comets, etc., seen in the sky during a total eclipse have been regarded by the superstitious as divine omens."

We have very little doubt that the great extension of the corona in certain directions during many total eclipses, and the probably far greater extension of a fainter, not readily discerned lustre during all

eclipses, is due to the existence of meteor streams. It is also undoubtedly true that several of the meteor systems encountered by our earth in her journey round the sun have the vast dimensions mentioned by Professor Abbe. Indeed, he far underrates the dimensions of the August and November meteor systems, each of which must be measured in length by hundreds of millions of miles, not by mere millions. But it is absolutely impossible that any of the meteor systems traversed by our earth, or any meteor systems of no greater degree of richness, should present the appearance of streamers surrounding the sun, like those in our figure above. So far as the two systems specially mentioned by Professor Abbe are concerned, inasmuch as we know the exact shape and position of the orbits along which the meteors forming these systems travel, we can determine the exact position which the meteoric streams occupy in the heavens at any moment; and most certainly neither of them on July 29th last occupied the position of the two beams shown across the sun in our figure. The August system was the one which at the time passed nearest to the sun's place on the sky, but it did not come within several degrees of the sun. The November system did not even cross the part of the sky where the sun was. These two systems, therefore, could not possibly be connected in any way with the two streams, of whatever nature, which produced the rays intersecting exactly at the sun.

But there is a more general objection to the theory that such meteor systems may explain coronal streamers seen during total eclipses of the sun. If such streams could be seen when situated beyond the sun, they would be seen far better when opposite the sun on the dark background of the midnight sky. Take, for instance, the November meteors. We know that the flight of meteors, some 2,000,000,000 of miles long, which the earth traversed in November, 1866, 1867, 1868, 1869, 1870, and 1871, is now nearing the remotest part of the long orbit of the November system, many millions of miles beyond the path of Uranus. We know that at midnight in winter the richest part of that system lies due south, at an elevation varying from 30° to 50° above the horizon. There, illuminated fully by the sun, though at a great distance from him, it ought to be far better seen than a similar system lying beyond the sun and visible only through the light of the brightest part of the corona. But no one has ever, on the darkest and clearest night and under the most favorable atmospheric conditions, even suspected the existence of the faintest possible light where the heart of the November system is really situated. Much less, then, could such a system be seen during total eclipse (if so situated as to lie athwart the sun). Systems less rich than the November system (the richest known to us) would have still less chance of being discerned.

If, then, we are to account for the radial streamers seen by Professor Abbe, and also seen during many other total eclipses, though to a less distance, by the meteoric theory, we must consider meteor systems

very unlike those through which the earth herself passes. The meteor systems required by the theory must be much denser and much more brightly illuminated than the August and November systems. To say they must be much more brightly illuminated is equivalent to saying that they must be much nearer the sun. And in this we see an escape from another difficulty. Meteor systems very near the sun would be far more likely to appear as streamers extending radially from him than systems at a great distance from him. A distant system might, by a mere chance, so appear. For instance, if a total eclipse of the sun had occurred on or about May 10, 1865, the November meteor system (whose richest part was then crossing the earth's track at the point she occupies on November 13th) would have appeared, if discernible at all, as a streak athwart the sun's place in the sky, and therefore forming two rays on opposite sides of him, somewhat like 2 and 5 in our figure. Sixteen years or so earlier or later the November system would present a similar appearance, only very much fainter, on account of greatly increased distance, during a total eclipse occurring on or about November 13th. At no other time in the year except November 13th and May 10th, or about these dates, could the November system present such an appearance. But a system traveling close to the sun, and not far from the plane near which all the planets travel, would present at all times nearly the appearance of a pair of rays like 2 and 5 of our figure. On this account, therefore, as well as on account of the greater brightness with which such meteor systems would be illuminated, we must prefer the theory that the systems to which the coronal rays are due travel near to the sun.

Yet, even as thus presented, the meteor theory alone seems inadequate to explain the coronal streamers. There is an enormous mass of evidence showing that meteor systems are most richly strewed throughout a region around the sun, extending nearly to the distance of the planet Mercury; but there is also abundant reason for believing that these multitudinous systems would present an appearance very different from that depicted in Professor Abbe's view of the coronal streamers. We want something quite distinct from the theory of a mere aggregation of meteors to account for these rays, whether pointed or fan-shaped, extending directly from the sun. The aggregation of meteors might present the appearance of a luminous cloud around the place of the eclipsed sun. This cloud might be to some degree radiated, because each meteor system would have a course carrying it either directly athwart the sun's place on the sky, or nearly so. But there would be nothing like those sharply defined streamers extending separately from the sun to distances of ten or twelve sun-breadths. Sir George Airy, describing the appearance of the corona during the eclipse of 1851, pictures just such a cloud as we should expect to result from the aggregation of meteors. "Its color," he said, "was white, or resembling that of Venus; there was no flickering or unsteadiness; it was not separated

from the moon, nor had it any annular structure : it looked like a radiated luminous cloud behind the moon." The long streamers manifestly require a different explanation.

We can not but think that the true explanation of these streamers, whatever it may be (we are not in the least prepared to say what it is), will be found whensoever astronomers have found an explanation of comets' tails. These singular appendages, like the streamers seen by Professor Abbe, extend directly to the sun, as if he exerted some repellent action on the matter forming the heads of comets. Indeed, Sir John Herschel did not hesitate to say that the existence of such a repulsive force was, to all intents and purposes, demonstrated by the phenomena of comets' tails. Now we know that meteors and comets are in some way associated, though the actual nature of the connection between them is not clear. It is certain that the November meteors, the August meteors, and other such systems, follow in the track of known comets. We know that when, in 1862, the earth passed through the region of space along which Biela's comet had recently traveled, there was a display of thousands of meteors, all radiating from just that part of the heavens from which bodies traveling parallel to the orbit of Biela's comet would have seemed to radiate. It follows from this association between comets and meteors, and from the fact that probably thousands of meteoric and cometic systems travel close to the sun, that in all probability there must exist generally, if not always, in the sun's neighborhood, enormous quantities of the substance whence comets' tails are formed by the sun's repellent action. This being so, we should expect to find generally, if not always, long streams of matter extending from the sun's immediate neighborhood, in the same way that comets' tails extend from comets' heads. Whether the repulsive force is electrical, magnetic, or otherwise, does not at present concern us; or rather it does concern us, but at present we are quite unable to answer the question. All that we know certainly is that, in the first place, the sun does in some way cause streams of luminous matter to appear beyond the heads of comets, in a direction opposite to his own, and to enormous distances; and, in the second place, that the matter forming comets' heads is probably present at all times, in large quantities, in the sun's immediate neighborhood. We can hence infer, with extreme probability, that such long streamers as Abbe saw last July, Myer in August, 1869, Feilitzsch in June, 1860, and several Swedish observers during the eclipse of 1733, are produced in the same way as comets' tails, and therefore really extend (as they seem to do) radially from the sun. It is also certain that if they did not really extend radially from the sun, their always seeming to do so would be altogether inexplicable. So that the theory to which we are led in one direction leads us also out of what would else be a very perplexing difficulty in another direction.—*Cornhill Magazine.*

SKETCH OF CHRISTIAN GOTTFRIED EHRENBERG.

By FREDERICK HOFFMANN.

AMONG the pioneers and master minds in the domain of natural science, during the first half of the nineteenth century, several have risen far above their contemporary co-laborers, and have attained to heroic prominence; while a few, transcending the limits of their own period, have largely contributed to giving shape and character to their time, opened and entered upon novel paths or new fields of inquiry, and thereby have immortalized their life-work, and their name in history's imperishable record. Among these sovereigns of science ranks CHRISTIAN GOTTFRIED EHRENBERG, whose labors and researches for more than sixty years have connected his name with the most illustrious scientific discoveries of modern times.

Ehrenberg was the son of a Lutheran minister, and was born April 19, 1795, at Delitsch, in Prussia. Having received a classical education at home, and at the famous Schulpforte Gymnasium, he entered the University of Leipsic in 1815 as a student of theology. During the three years' course of theology, he also occupied himself with the study of natural sciences, and, through his increasing interest in the wonders of the creation, took up the study of medicine in 1818 at the University of Berlin, then as now the greatest and foremost of German universities. His efforts and researches were soon directed toward the investigation of the minute organisms and the ultimate forms and phenomena of organic life. Since the time of that first remarkable triumvirate, Malpighi, Grew, and Leeuwenhoek, who toward the close of the seventeenth and in the opening of the eighteenth century had laid the scientific foundations of the microscopical method of investigation, hardly any substantial addition, beyond those awakening mere curiosity, had been made to the observations of those eminent investigators. At the beginning of the nineteenth century, Dutrochet, Mirbel, Saussure, and Knight had inaugurated a more searching investigation into anatomy and physiology. Link, Treviranus, and Rudolphi followed with still more elaborate and comprehensive researches, and paved the way to the discoveries early attained and rapidly accumulated by Ehrenberg's genius and industry. His master mind discerned the disconnected facts and details of his material in the light of uniformity and generalization. In lieu of the then prevailing belief in *generatio equivoca*, one of the first achievements of Ehrenberg was an account of a long series of investigations, at once strikingly acute, thorough, and convincing, of a large number of fungi, demonstrating that they, no less than the higher vegetable organisms, originated from seeds. He soon explored the cryptogamic flora of the environs of Berlin, and published a series of

important discoveries in his dissertation entitled "Silvæ mycologicæ berolinenses" (1818), and in other essays. To the former he prefixed the motto, which became, as it were, the key-note of all his later labors and works:

> Der Welten Kleines auch ist wunderbar und gross,
> Und aus dem Kleinen bauen sich die Welten.[1]

While still a student, the novelty and exactness of his observations and researches, and the high order of his deductions, at once established their author's reputation; and many of the eminent scholars and professors of the Prussian capital encouraged and aided the rising investigator, among them Lichtenstein, Alexander von Humboldt, Rudolphi, Link, Klug, Von Schlechtendal, Adelbert von Chamisso, Carl Ritter, Kunze, E. Mitscherlich, and others. After having passed the state medical examination, he was proposed for a professorship at the University of Königsberg, and also by the Berlin Academy of Sciences as a scientific *attaché* to an archæological expedition to the Nile countries, instituted by the Prussian General von Minutoli. He accepted the latter offer, together with his friend Dr. Hemprich, of Berlin. The expedition started from Alexandria in Egypt, in September, 1820, went through the Cyrenaica to the oasis of Jupiter Ammon, back to Cairo; in 1821 to Fajum, the pyramids of Sakhara, to Dongola in Nubia; in 1823 to the Sinai peninsula, to Syria, the Lebanon ranges, to Balbek and return by the way of Tripoli to Damietta. These expeditions were followed by others into Abyssinia, sailing down the Red Sea, stopping at and making trips to Tor, Djedda, Mecca, the islands of Gumfude, Ketumbul, Dalac, Farsan, etc. At Massauna the joint expedition came to an untimely end by the death of Dr. Hemprich in 1823. Ehrenberg then accomplished the plan of their mission alone.

To what hardships and dangers Ehrenberg was exposed for years while traveling through and exploring arid deserts, amid hostile tribes of marauding Arabs, during the prevalence of an epidemic of the plague, and unprovided with any of the comforts and conveniences of later expeditions, may be seen from the simple fact that the expedition lost seven of its members by death, and that of its scientific *attachés* Ehrenberg alone survived. He returned to Berlin in 1826, with magnificent collections of botanical, zoölogical, and geological specimens, embracing all departments of natural science, and an immense number of microscopical preparations until then unknown, and which remain for verification and ready inspection to this day. The extent and importance of these rare collections may be estimated by the mere statement that they included 46,000 botanical specimens, representing 3,000 species of plants; about 34,000 specimens from the animal kingdom, representing 4,000 species; while no less comprehensive were the

[1] The small too in the universe is wondrous and great,
And worlds are constituted out of that which is little.

geological and ethnographical collections, the geographical and meteorological observations, and other results of the expedition.

Considering such material mainly as requisite means for investigation and for comparative study, Ehrenberg now applied himself with unceasing zeal and diligence to his rich collections, assisted by eminent scholars and artists, for the illustration of microscopical objects. The results were published during the years 1828–1830, in a volume entitled "Scientific Travels through Northern Africa and Western Asia, by Ehrenberg and Hemprich," and in a series of elaborate, strictly scientific works, written in the Latin language, with more than eighty splendid illustrative plates, the principal ones being the following: "Symbolæ physicæ, seu icones et descriptiones mammalium" (1828), "Symbolæ physicæ avium" (1828), "Symbolæ physicæ insectorum" (1829–1834), "Symbolæ physicæ animalium evertebratorum sepositis insectis" (1829–1831).

The continuation of these consummate researches and labors was interrupted for about one year, when in 1829 Alexander von Humboldt, Ehrenberg, and Gustav Rose, on invitation of the Russian Government, undertook an expedition to the Ural and Altaï regions, with the special aim of exploring their mineral resources. After the return from this exploration, Ehrenberg entered upon the most fruitful epoch of his labors and career: he accepted a professorship at the Berlin University, but still continued his original researches with unceasing assiduity. His first publications had already attracted the attention of the learned throughout Europe, and secured for the young investigator a reputation among the remarkable array of *savants* then in Berlin. When that severe critic, Cuvier, in 1830, presented Ehrenberg's first publications to the "Institute of France," he accompanied them with these words: "Ces découvertes changent entièrement les idées et renversent surtout bien des systèmes, elles sont du nombre de celles qui font époque dans les sciences."

The continuous series of publications founded on and recording his discoveries and researches, had reference principally to such problems and objects as the phosphorescence of the ocean, corals, fossil as well as living deposits of minute organic remains in the strata of the earth's crust, the minute organic life in the atmosphere, the phenomena of blood rain and snow, dust-showers and the "Bleeding Host," which latter one, during the middle ages, was the cause of the most barbarous excesses of the Inquisition. All these investigations and works were followed by his splendid exploration, beginning with 1840, of the minute organic creation, and by the disclosure of the influence of that "realm of littleness" in the development of the present condition of the earth's crust, and on the whole organic life of nature.

In consummate generalizations he laid down the results of his life-long, profound, and comprehensive observations and researches in the most famous of his many works, "Microgeology" (1854). Henceforth

governments, travelers, and scientists, from all parts of the globe, submitted specimens and problematic objects to the investigation or the verdict of the Berlin microscopist and *savant*. Deep-sea soundings, which began about this time, were especially fruitful in material for research; and the surprising result was brought to view that organic beings exist even at the greatest depth of the earth's submarine declivities, previously believed to be void of life.

Those who, in common with the writer, during Ehrenberg's most productive years, have witnessed and participated in the ardor and enthusiasm of the great and genial scholar and teacher, will ever remember with veneration the originality and conscientiousness of his methods of research, his wonderful skill, elegance, and acuteness in microscopical observation, and, above all, the lucid and graphic description of the master whose eyes undoubtedly had done more close and critical microscopical research than those of any contemporary. In him were fully and harmoniously blended the strictest sense of duty and truthfulness, the highest order of intellectual attainments, the exquisite taste of the accomplished classical scholar, and the charm of religious faith, genial disposition, and a generous heart.

Ehrenberg continued his work steadily and unfailingly to the end of his life, even when his eyesight had become impaired by protracted application, and when almost all of his famous contemporary co-laborers at the Berlin University had passed away.

In reviewing the discoveries, the works, and achievements of Ehrenberg, one is strongly impressed by their vast number and their high order in a domain at once so abstruse and so unlimited. In his hands, microscopical research first attained its proper application and a definite character, and revealed new fields of inquiry, afterward successfully trodden by others; his physiological and biological investigations paved the way for those discoveries which, in rapid succession, have been since effected in the structure and processes of the human body in health and disease, and which have shed much light upon the progress of every branch of the healing art. His researches and achievements contributed to every department of the physical sciences; the minute organic creation became, for the first time in our knowledge, a new link in the scale of animated beings, and its influence upon the formation of the strata of the earth's crust and their geological history was recognized. All the writings of Ehrenberg, the occasional orations and addresses delivered by him as Rector Magnificus of the University, as Permanent Secretary of the Berlin Academy of Sciences, etc., are masterpieces of learning, of exquisite style, replete with exalted ideas, and form enduring evidences of their illustrious author's eminence. His name will ever be honored as the father of modern microscopy.

How profoundly faith and rare modesty were congenial to his mind, will appear from the following brief passage from one of his latest rectoral orations: "Investigators and writers who, because at the limit of

their knowledge and powers, conclude that there is no soul, *ergo* no immortal life, may from their own point of view be quite right; but they are not on that account by any means to be accepted as representative men of science. The proper sentiment of the naturalist is this, that so far from pretending to inspiration or infallibility, he humbly recognizes the limitations inherent in his own intellectual powers, and imposed upon him and his time; while with all the faculties of his mind and soul, and with faith, he labors unbiased and assuredly, aiming at truth and confident of the usefulness of his life-work to his own or to subsequent generations, who sooner or later will recognize every true contribution to the stock of knowledge and to a purer and profounder insight into the wonders of the creation. The true investigator of nature should never divest himself of the idea that he is, as it were, a son in his Father's house and a co-worker, in his own humble sphere, with the great Ordainer of the universe."

The universal appreciation of Ehrenberg and his achievements found a spontaneous expression on the occasion of the celebration of the fiftieth anniversary of his doctorate in medicine, on November 5, 1868, when felicitations and honors poured in upon the veteran *savant* from all countries. The United States were represented in official congratulation by their Minister Plenipotentiary, Mr. George Bancroft, and in addresses from the American Association for the Advancement of Science, the American Medical Association, the American Pharmaceutical Association, and also in a poem by Dr. O. W. Holmes. These tributes were presented by Mr. Bancroft, who afterward had them all printed in a pamphlet.

Devoted and faithful to his life-work, he maintained his powers and his activity to the end. As stirring and brilliant as the day of his life had been, was its evening serene and hopeful; gently and without pain he passed away, on the 28th of June, 1876, in his eighty-second year.

His large and invaluable collections he bequeathed to the Museums of the University of Berlin.

CORRESPONDENCE.

SINGING MICE.

To the Editors of the Popular Science Monthly.

READING the article in your November number from "Nature" on "Singing Mice" recalls my experience with one of these interesting little animals: Some years since, while residing at Santa Fé, New Mexico, one of these vocal mice made its appearance in my house. The sounds were noticed some time before the animal was seen. As with Mr. Lee's mice, there was a canary-bird in the room, and for a time the notes coming from the wall were attributed to the canary. At last, however, the mouse would come out on the carpet seeking for crumbs, and there sing. The notes were almost identical with those of a canary. It would not trill so long, but in pitch and tone were identical —at least to an unmusical ear. The same filling and throbbing in the throat seen in a bird were also seen in the mouse while he sang The sound was not sibilant, but strictly canorous with the pitch of an ordinary canary. After this mouse had furnished entertainment for a month to myself and family, I found him so tame I could touch him, and that he was utterly blind. It was very touching to see the gentle little creature turn up its cloudy, sightless eyes to the candle when he was brought near to it on the floor of the dining-room. Small parties would assemble in the evening to hear this wonderful little vocalist without frightening him. He would come out on the carpet with all the confidence and *aplomb* of an old actor, and delight his hearers. I was afraid to keep him in confinement for fear he would die. Our cat was banished for the same reason, and we would not set any traps for fear he would be caught. Finally, we became so overrun that we had either to commence hostilities or abandon the house. We set a trap in a cupboard in the room, and, alas! poor little singing Mus was the very first victim. I found, on examining the body, that he was exceedingly old—so old as to be blind, as I remarked—and his teeth were very long and yellow. The lower ones had grown up above the nostril. The existence of messmates or anything internal I did not verify. As for the theory of this accomplishment being the result of pregnancy, that was eliminated by the sex. I then had an idea that the sounds might have been produced by the air being forced through the long, overgrown gnawers, they acting as a sort of string. The animal was a true mouse. We have here a rat very little larger than a mouse, but it was not one of these. It was identical with the ordinary American mouse, and there was no peculiarity in color or length of ears, as remarked by Lee. This was the only one I ever had an opportunity of examining. The Mexicans, however, say they are not uncommon, and are superstitious about their appearance. My servants were greatly distressed and alarmed at the death of this one: a coincident ill fortune in the family was looked upon as having a plain and sufficient *raison d'être*.

LEWIS KENNON, A. M., M. D.

FORT BAYARD, NEW MEXICO,
January 14, 1879.

DR. LARDNER AND TRANSATLANTIC STEAM-NAVIGATION.

To the Editors of the Popular Science Monthly.

IN your February number, Dr. Burns somewhat autocratically takes you to task for stating that Dr. Lardner had declared in some of his earlier lectures that steam-navigation across the Atlantic was "impracticable," and he quotes, from a very imperfect edition of Dr. Lardner's early lectures on the steam-engine, a foot-note by Professor Renwick, to show that it was the latter and not Dr. Lardner who at that time deemed the experiment impracticable.

As usual, you are correct in your statement, and Dr. Burns has fallen into a very material error, in the first place from not understanding the position of Dr. Lardner as implied by your remark in the December number of the journal, and from evidently not having read Dr. Lardner's later and fuller lectures on "The Prospects of Steam-Navigation," delivered in the principal cities of the United States during 1843 and 1844. The best edition of these lectures is the one published by Greeley and McElrath, of the "Tribune," in 1846, which edition was revised for publication by Dr. Lardner himself. I quote from his lecture on "The Prospects of Steam-Navigation," as found on page 269 of Volume I. His lecture begins with this statement of the facts obtaining then, as to ocean navigation, and his opinion as to its practicability:

"Ten years have now rolled away since the project was first announced to the world, to supersede the far-famed New York and Liverpool packet-ships, by a magnificent establishment of steam liners. . . . The

announcement was hailed with one general shout of acclamation. . . . There were some, however, who, being conversant with the actual condition of the art of steam-engineering as applied to navigation, . . . were enabled to estimate, calmly and dispassionately, the difficulties and drawbacks, as well as the advantages of the undertaking. . . . These persons entertained doubts, which clouded the brightness of their hopes, and warned the commercial world against the indulgence of too sanguine anticipations of the immediate and unqualified realization of the project. But the voice of remonstrance was drowned amid the loud shouts of public enthusiasm, excited by the promise of an immediate practical realization of a scheme so grand.

"The keel of the Great Western was laid, an assurance was given that the seasons would not twice run through their changes before she would be followed by a splendid line of vessels which should consign the 'packet-ships' to the care of the historian, as 'things that were.'

"The Great Western progressed and was launched, and the enterprise has now had a fair trial during ten years, a sufficiently long time, it is presumed, to test it. The packet-ships, however, have not been swept from the ocean; on the contrary, they have been improved in efficiency, increased in magnitude, and multiplied in number. Capital, instead of being drawn from them, allured by the prospective advantages of the steam liners, has only collected around them in augmented amount, obeying, as it always does, that irresistible attraction which profitable results invariably exercise in commerce. On the other hand, the steam project which was to prove their doom has made its flash, and disappeared, leaving the Great Western . . . alone in her glory . . . *to establish at once the abstract practicability of the scheme in a mechanical sense, and the utter inadequacy of its organization in a commercial sense.*"

This was the opinion of Dr. Lardner in 1846, nearly twenty years after the publication of the edition of his lectures quoted by Dr. Burns, and more than ten years after ocean steam-navigation had become an established mechanical fact. The views entertained by Dr. Lardner at that time were very simular to those entertained by scientists to-day in regard to the problem of aërial navigation, mechanically practicable, but in the present conditions of inventions pertaining to it, so far as its commercial value is concerned, an impracticability; moreover, Dr. Lardner, in the lecture from which I quote, uses almost the same arguments quoted by Dr. Burns, from Professor Renwick's foot-note, viz., the large amount of fuel necessary for long ocean voyages, and the great expense attending its use, as compared with the cost of sailing vessels.

Dr. Lardner, however, lived to see ocean navigation by steam a success, commercially as well as mechanically, and to qualify many of the ideas and arguments advanced in his earlier lectures.

Very respectfully,

A. W. Erwin.

Sioux City, Iowa, *February* 3, 1879.

EDITOR'S TABLE.

MORE ROOM FOR THE SCIENCES.

IT can not be kept too clearly in mind that the broad issue of modern educational reform is whether sciences or languages shall predominate as objects and instruments of culture. Shall physical nature, life, man, society, and the actual phenomena of experience, become the leading objects of study; or shall the acquisition of forms of speech, the accumulation of verbal symbols, and the discipline of grammar-grinding continue to hold their traditional ascendancy? No question now arises as to taking both of these modes of mental culture along together, for it is conceded on all hands that neither can be dispensed with, but the contest is as to which shall lead in a rivalry of widely different systems. The issue is, by which method shall the education of the future be characterized?

The languages are in possession, and of course have great advantages in the conflict from this fact. For the notion has grown up that a liberal knowledge of language *is* education, while nothing else is properly entitled to the name. Lingual studies, moreover, have the vast advantage that they are taken as the standards and measures of acquisition. Memorizing words, learning rules, construing and translating, make proficiency easily determinable; and when

scientific studies are introduced, as their results are not measurable by these old standards, it is inferred that they are not measurable at all, and are therefore unfitted to form the staple of systematic education.

But, although much is made of this difficulty, it is not serious. Science will create its own standards when it has had time and experience, and meantime its demands are for opportunity—room—facilities. An edifice can not be constructed until space is first granted for it to occupy; scientific education can not be organized until time and materials are yielded for the purpose. Old studies must be put out of the way, that new studies may take their place and the new education have a free course.

From this point of view we note and record with interest all indications that the old subjects which are now holding their place by the right of prescription and any pretexts that are available are yet compelled, by the tendencies of the times, to abandon their claims and surrender their ground. The advocates of the dead languages fight desperately to maintain their ancient precedence, but they are losing the battle. Even in England, where the whole framework of society is braced and bound by endowments which conserve the old and resist the new, and where the universities and public schools, rich and independent, combine against all modern encroachments, there are increasing indications that the old classical claims are regarded by their partisans as now untenable and must be given up. It is virtually if not avowedly conceded in high quarters that one or other of the dead languages must go, and in fact the classicists are already themselves at loggerheads as to which it shall be.

A step in the liberal direction was taken a few year ago, when the grammar-schools were remodeled by the Public Schools Commission by ceasing to make Greek an ordinary subject of instruction, and allowing the substitution for it of French or German. But now a still more significant step has been taken by several head-masters and other gentlemen interested in education, who have united to petition the authorities of Cambridge so to revise the scheme of university studies that Greek may be omitted if the student does not choose to learn it. At present it is a compulsory study, so that, though men entering the university "may be the equals of Airy and Adams in pure mathematics, of Tyndall and Huxley in natural science, of a Whewell and a Hamilton in moral science, they must be able to read a play of Euripidis and the Greek Testament, or Cambridge will not have them among its graduates."

The appearance of this memorial, signed by various weighty names, as might have been expected, has raised a controversial storm which has been chiefly vented through the columns of the London "Times." Mr. Oscar Browning led off with a letter full of sad forebodings, remarking, "To those who believe that national intelligence is the final cause of national greatness and prosperity, the proposal to surrender Greek will sound like the knell of disaster." The quiet way in which such a smattering of Greek as the students get at the universities is here taken as the equivalent of that national intelligence which leads to national greatness, shows us at all events that Mr. Browning believes in his Greek. He is, however, aware that there is another kind of knowledge with strong claims to attention, and thus refers to it: "There are many who look forward with satisfaction to the decay of classical education. In their eyes modern science, modern literature, modern interests, are fitted to give a wider and better education than was ever given by the contemplation of antiquity. The new learning which clamors on all sides for recognition, calls out their enthusiasm and zeal; the old learning

is discredited, as the subtilties of the schoolmen were discredited at the time of the Renaissance."

Mr. Browning has not much faith in this kind of knowledge for purposes of education, but, if it is bound to come and something must be given up, he will stick by his Greek, let who will suffer. He says: "If one of the two languages must go, let it be Latin. Greek is in every respect more valuable. As a language it is more beautiful, more rich, more flexible. Its literature is incomparably superior. The loss of Latin can be compensated by the languages derived from it. Nothing can supply the place of Greek. It is idle to suppose that if Greek were omitted from our regular school curriculum it would continue to be studied by the older boys."

Nothing certainly could be more idle, for the study is not adapted to modern general wants, and therefore has to be maintained by compulsion and its position maintained by an artificial coercive policy. Science, on the other hand, has grown up outside the schools, without endowments, and has been mainly developed by private enterprise because it is adapted to the present stage of progress of the human mind.

One of the "Times" correspondents thus replies to Browning's suggestion that Latin be sacrificed:

"The answer to Mr. Oscar Browning's question, Why should not Latin be thrown over, if one of the two classical languages must cease to be compulsory at the universities? is not far to seek. It is true that Greek is easier to learn, can be mastered thoroughly in less time, has an incomparably finer literature, and brings back times of greater interest than Latin; but these advantages are surely trifling when compared with the fact that Latin is the foundation of the languages which half Europe speaks and all Europe understands, and that it was a Latin-speaking people which formed the institutions, legal, social, ecclesiastical, and political, which we now maintain. I suspect that the genius of the English character is too Roman, or at least too anti-Hellenic, to gain as much from a moderate acquaintance with Greek culture as it has gained from a moderate acquaintance with the prominent Latin authors."

RESTRICTIVE TENDENCIES IN GERMANY.

THE great German experiment in empire-making conducted in these modern days by the "man of blood and iron" brings with it a train of developments which would be startling if they were not so legitimate and natural. Bismarck has the reputation of being a man of action and a great practical administrator, but behind and deeper than all this he is a thinker and a *theorist*, and the final estimate of him will depend, not on the greatness of the transactions which he has directed, but upon the character of his opinions. He holds certain hypothetical views of human nature, society, and government, and upon these he acts: the question is, Will time vindicate their truth? He is now at the height of power, and is lauded as a bold, sagacious, far-seeing statesman: will the future disclose him as a purblind political quack, as ignorant of his age and of all conditions of national permanence in modern times as the brilliant French adventurer who ravaged Europe in the beginning of the present century? This we shall not undertake to decide, but it looks, at any rate, as if Bismarck were cutting out work for his successors which they will probably not be able to perform.

When recently Professor Virchow solemnly admonished the scientific men of Germany to beware how they exercised the liberty of scientific discussion, lest they provoke governmental interference and suppression, it was thought, outside of Germany, that he was hardly in earnest, and was merely girding at

the Darwinians for the sake of effect. Yet he appears to have spoken as if by instruction, for it seems the determined plan of the Imperial Government not to allow that measure of freedom in speech which has become the established policy in other leading countries.

Constitutional government in Prussia, however, is but a recent thing, having sprung up within a generation; while the new German Empire was constituted by the treaties made at Versailles in January, 1871, during the Franco-German war. Taking into account, therefore, the previous discipline of the people, and the coercive military character of German state policy, too much in the way of liberality is certainly not to be expected in a short time. But it is nevertheless interesting and instructive to see how things hang together, and how one thing involves and leads to another in a thoroughly arbitrary form of government.

The German Empire, made up by the recent amalgamation of twenty-six states, and containing about 43,000,000 people, sustains an army on a peace-footing of 1,283,791 soldiers, with 31,843 officers and upward of 300,000 horses. Military service is compulsory, and the army is sustained by conscription. The strengthening of the measures by which the military system is maintained is illustrated by the following paragraph which recently appeared in the newspapers: "Sixty young men having quitted the district of Thaun, Alsace, to avoid conscription, they have been sentenced, by default, to 1,200 marks fine, or 200 days imprisonment, and to the seizure of their property to that amount."

That the maintenance of such a vast army in time of peace by grinding taxation, and for purposes of despotic violence, should have engendered a profound spirit of revolt against the institutions and social order of the country, is not surprising. Socialism is but the correlative of a rampant imperialism—the shadow of Bismarck. Did the Chancellor expect that people with their eyes open would not observe, and in this age that they would not think and comment upon what they saw? At any rate, he resolved to stifle all expressions of Socialistic doctrine in the German Empire, and this he is no doubt at present quite able to do. The effects of the Socialist law are thus represented by a writer in Berlin: "The Prussian and German police in general is an admirable piece of machinery. It is almost as thorough and effective as the German army. It has never done its work better than in hunting down the Socialists. Up to December 22d, 144 clubs, 44 newspapers, and 157 books and pamphlets had been suppressed." The slaughter, or "pig-sticking," as the Chancellor is said to have grimly styled the game, has gone on briskly since that time; and the columns of the "Reichsanzeiger" give no sign that the authorities are becoming weary or merciful. The chief Socialist leaders have been turned out of Berlin, and it is difficult for them to find in Germany rest for the soles of their feet. Some are in prison. A few have emigrated in despair to America. In a few weeks perhaps no trace of the Socialist agitation will be discernible on the face of German society. But will the danger be gone when it is put out of sight? The Chancellor can not draw a cordon round the Fatherland and exclude the poisonous literature printed in London, Brussels, Verviers, or Geneva. The malady will not be cured because it is driven into the system. The seductiveness of Socialist opinions will not be a whit less than it is because the Government appears to dread them, and to have no confidence in the weapons of reason against the wild ideas that have taken hold of multitudes.

Believing in no half-way policy, Bismarck has now pushed his tactics a step further; the gagging of the people

is followed by a proposal to gag the German Parliament, the "Reichstag." Previous enactments having muzzled the press and silenced the voice of public meetings, a law was still required to fetter legislative debate whenever it threatened to take a range displeasing to the authority by which the country is really ruled. It is difficult for us to put the case in any other way than that Bismarck is ruling Germany by a policy which he knows will not bear free discussion.

That a Government founded upon arbitrary power, which plunders the country to sustain its armies, drags young men into its armies, drives children to school, and crushes the liberty of speech, should apply its restrictive methods also to trade, is not surprising. The enslavement of commerce belongs with the other tyrannical practices and enactments of the past; and the liberty of commerce can come only with the other liberties when the militant compulsory forms of society are outgrown or subordinated. That Bismarck should favor the hampering of German trade by increasing restrictive duties, as shown by a recent letter upon the subject, is no more surprising than his violations of the other natural rights of German citizens. Tariffs are the best means by which rapacious governments can get possession of the money of the people, and Bismarck must have money.

LITERARY NOTICES.

ORIGIN, PROGRESS, AND DESTINY OF THE ENGLISH LANGUAGE AND LITERATURE. By JOHN A. WEISSE, M. D. New York: J. W. Bouton. 1879. Pp. 800. Price, $5.

Two purposes are intended by the author of this work: first, to set forth a history of the English language and literature; and, second, to show the fitness of the English to become the universal language of civilized man. The Anglo-Saxon, the source from which English has sprung, was a composite language, consisting of three principal Gotho-Germanic elements, viz., the slightly variant dialects of the three northern nations which in the fifth century established themselves in Britain—the Jutes, the Saxons, and the Angles. The author's plan did not contemplate any set inquiry into the origin of these dialects; he has but little to say about their descent from one more ancient mother-language—the Aryan—he simply accepts them as a fact, and then proceeds to show how by the natural process of development, profoundly modified by the environment, they, or rather the one composite language, Anglo-Saxon, was compounded with other elements to form first the Franco-English (A. D. 1200 to 1600), and finally the English language as it now is. Dr. Weisse's method consists in setting before the reader specimens of the literature of the successive centuries from the invasion of the Angles, Saxons, and Jutes, down to the present time, and classifying the words according to the linguistic sources from which they come. The result shows the proportion of Anglo-Saxon, Latin, Greek, French, and other elements constituting the sum of the language at any given period. It shows, further, the changes undergone by the *form* of the language, if we may so designate its grammar, as distinguished from its *matter*, i. e., its vocabulary. Anglo-Saxon was a language possessing a variety of inflections to designate by the termination or by prefixes the diverse relations between words or their significates. Of these inflections English retains but few: a possessive (or genitive) case for nouns; an accusative (or dative) for some pronouns; the plural sign *s* final for nouns, and the final *s* in the third person singular of the verb; an imperfect (or aorist) tense of verbs; and perhaps some other traces. For the most part we now express by "prepositions," or by "auxiliary verbs," the relations expressed in Anglo-Saxon by inflections, or root modifications. Our author's specimens from the literature of the successive ages make all this very plain. Then the changes in the *matter* of the language, its invasion by foreign words, are exhibited. The first literary specimen in the volume is taken from Ethelbert's code of laws, which dates from the year 597. Here, as in the case of all the specimens

cited by the author, the linguistic source of each word is stated, and it thus appears that in Ethelbert's time out of 100 words not over six were other than pure Anglo-Saxon. Compare with this the constitution of English. Dr. Weisse finds that out of 100 words in the Bible 78 are Anglo-Saxon; in Samuel Johnson, 51. But of this side of the work we have written enough.

Dr. Weisse was an utter stranger to English up to his thirtieth year, and his estimate of the value of our language at that time was in direct ratio to his ignorance of it. Convinced of its inferiority to certain other languages, he commenced the researches of which this volume is the result, for the purpose of demonstrating that inferiority. His studies satisfied him that English "contains the cream and essence of its predecessors and contemporaries; that its grammar is simpler, and that its records and literature are more consecutive and complete, than those of any other tongue." He is not content to class English with the best languages of the globe; it surpasses them all: it is *the* best, the most flexible, the one language of all that have ever existed which is most suitable to become a universal language. But there exist some slight hindrances which Dr. Weisse labors to remove, and the principal one is that we do not "write as we pronounce or pronounce as we write." If our "orthography" were reformed and a few syntactical anomalies corrected, nothing could prevent the English from becoming universal. Already it is spoken by some 90,000,000 people, and English-speaking nations are the masters of a far larger area of the inhabited globe than are the nations using any other tongue.

The author does not confine himself very scrupulously to the programme indicated in his title, but is ever digressing to the right hand and to the left. His business is with the English language as it has been and as it is, but for page after page the reader might suppose that he was perusing a dogmatic treatise *de omnibus rebus*. Dr. Weisse himself is not unconscious of the irrelevancy of much that he has written, but he excuses it on the ground that his digressions serve to amuse the reader and make the perusal of the work a pleasure instead of an irksome task. For our part, when we wish to learn the truth about the supposititious visit of St. Paul to Britain, the history of Pelagius, or other topics, we prefer to get our information from the histories which deal with those subjects. Though not uninteresting, these digressions are a blemish, and should be omitted if the work reaches a second edition. The volume is a valuable contribution to the history of the English language, and we bespeak for it the earnest attention of our readers.

A Treatise on the Law of Property in Intellectual Productions in Great Britain and the United States. Embracing Copyright in Works of Literature and Art, and Playright in Dramatic and Musical Compositions. By Eaton S. Drone. Boston: Little, Brown & Co. 1879. 8vo, pp. 774. Price, $6.

The popular interest which the subject of the rights and wrongs of authors has recently awakened in England, France, and the United States, and the uncertainty and confusion into which the law of copyright has been allowed to drift, make a satisfactory treatise on this subject as welcome to men of letters as to the legal profession. The book before us is beyond comparison the most thorough and critical work on literary property yet published in England or this country, and, though an American publication, it is as complete an exposition of the English as of our own law. Our readers will remember that in his evidence before the English Copyright Commission, which we reprinted in the December "Monthly," Professor Huxley maintained that there was no distinction in principle between literary property and any other kind of property. Herbert Spencer and Professor Tyndall, who also testified before the Commission, were evidently of the same opinion. In a preliminary essay on "The Origin and Nature of Literary Property," Mr. Drone has gone to the bottom of this subject, and by an elaborate examination of all the principles, authorities, and arguments which bear on it, shows that literary property has the same general attributes and is governed by the same general principles that obtain in the case of all property. Hence the right of an author to his intellectual productions is no more a monopoly subject to the whims of the

Legislature than is the title of the owner to his lands or bonds. Until about a century ago this principle was recognized and acted on in England, where perpetual copyright in printed books was not denied till 1774, when the House of Lords, following the empty declamation of Lord Camden instead of the sound opinions of Lord Mansfield, Sir William Blackstone, and other learned jurists, decided, on an equal division of the judges, that authors had no rights in their published works excepting what Parliament might choose to give them. This decision has since controlled the law in England and the United States, but, as Mr. Drone forcibly maintains, it was "contrary not only to right and justice, but to the true purpose and meaning of the statute" (of Anne) "as determined by settled rules of construction."

The question whether the unlicensed abridgment of a copyrighted book is piratical, is one which is likely to be brought home to any author of an elaborate work. If the law on this point is governed by loose judicial *dicta* and doubtful precedents, honest authors have little reason to hope for protection against piracy. But Mr. Drone, following his plan of determining the law by governing principles, shows that the unauthorized abridgment of a copyrighted work is piratical. After a thorough discussion of the subject, he thus sums up the whole matter: "A genuine abridgment embodies the substantial results contained in the work abridged, and, if unauthorized, is damaging to the author of the original. The question of piracy is determined by the application of the established principle that no one without authority shall take a material part of another's work to the injury of the person entitled to protection. It is settled that piracy may be committed by taking a few pages from a copyrighted book; to hold that the substance of the whole may be lawfully appropriated, if published in the form of an abridgment, is as absurd as it is inconsistent and unjust." Under the head of blasphemous publications, he considers the question whether a work hostile to religion is entitled to copyright. Lord Eldon refused an injunction against the piratical publication of Sir William Lawrence's "Lectures on Physiology, Zoölogy, and the Natural History of Man," on the ground that the original contained passages which "impugned the doctrines of the immateriality and immortality of the soul." For similar reasons, the same judge refused to protect Byron's "Cain." Mr. Drone criticises these decisions as being unsound and illiberal, and maintains that even in England, where the law on this subject is more stringent than in the United States, there is no good reason why protection should be denied to publications in which the prevalent doctrines relating to religion are doubted or denied with moderation and sincerity.

Many other important and interesting questions are ably discussed in language which is singularly concise, clear, and free from legal verbiage. The work will doubtless take its place as the standard authority on the subject of which it treats.

FERNS IN THEIR HOMES AND OURS. By JOHN ROBINSON. S. E. Cassino, Publisher. Naturalists' Agency, Salem. Pp. 178. Price, $1.50. Illustrated.

THIS is the first American work devoted exclusively to the cultivation of ferns, and it is intended to serve as a guide to those in this country who are interested in the subject and would like to know how ferns may best be cultivated. The spirit of the book is well expressed on its last page in the following words: "The writer will not claim that the fern-mania, which may be traced from its beginning across the ocean to its recent development in this country, is a hobby superior to most others; but he does claim that, properly guided, it can be the means of stimulating pure and healthy exercise and study; and that, whether pursued in a scientific way or only as a pastime, it can in any event do no harm, but may be the cause of great and permanent good. If this little book shall in any way conduce to the love of the graceful plants of whose culture it treats, or aid any beginner in the study of the ferns, the writer will feel that another pleasure has been added to that which he has already experienced in its composition."

As an example of the ability of the author to carry out his purpose, we quote the following from Chapter V., entitled "How to collect Ferns for Cultivation." Premising that the desire to collect ferns is

a natural accompaniment of vacation-trips, the author says:

When we meet them in their full beauty they are in the most unfavorable state for transplanting, as, in the vigor of its growing condition in its natural home, a fern will endure little rough handling, and requires tender care to persuade it to grow in any other place. It would be better to wait till the season's activity is passed, which it is probable we can not do; or collect our ferns in the early spring, before the croziers unroll; but when the plants are in this condition, only an experienced botanizer knows what to look for and where to find it. Suppose, then, that in July or August we wish to obtain a small collection of our native ferns in their living state. The best way of transporting them is, of course, with their fronds uncrushed, in a box or basket of sufficient size. But this is not always practicable. It may be necessary to condense them into the smallest possible space. As we collect them the ferns can be kept in a bowl or basket till we are preparing for our journey home. When we gather them the roots should be carefully dug up, not wrenched from their surroundings; and, when we begin to get them ready for their travels, should not be very wet. Suffer the plants to remain without water a day or two before packing, only do not allow them to become exactly dry. Then we may shake off as much of the earth as will readily fall away, and, wrapping each fern with a bit of damp (not wet) moss, roll it up in a bit of paper large enough to hold all together, tying the parcel with a thread. The fronds should all project beyond the moss and paper, and only enough of them be left to insure a healthy start the next season—three or four on an ordinary and six on a very large plant. To remember how the ferns looked (for we are not yet supposed to know their names), it is a good plan to press a frond of each, and number it, tying a tag with the corresponding number to the specimen itself. When this is done, all the packages should be arranged with the fronds lying in the same direction, and a number of fresh fronds should be collected and tied around the fronds of the ferns to be carried home. Then the whole may be rolled up firmly into a bundle, covered with several thicknesses of stout manila paper and tied securely. The package is now ready to place in a trunk to deliver to the expressman or carry under the arm. Unless it is exposed to the sun, or in a very dry place, this bundle will not suffer in vitality or health for two or three weeks. At the journey's end the ferns must be carefully unwrapped and firmly planted in a good light soil, whether out of doors or in the fernery. At first nearly all the fronds will lie quite prostrate on the ground, but if they are frequently sprinkled on both sides and their roots kept only damp, the plants will establish themselves and reward the pains bestowed upon them by a fine healthy growth the next season.

The volume contains six colored illustrations of interesting species, and numerous plates illustrative of the growth and culture of ferns. A very tempting frontispiece shows the fern-corner of the writer's greenhouse. There is an important chapter concerning soils and pots for ferns, with pictures of pots of several different forms: one upon fern-cases, another with lists of ferns suitable for cultivation in tropical and temperate houses and in fern-cases. Fern-pests are also discussed, and pictures of nine of these creatures are given in plate 22. But further details are needless; the book teems with useful instruction from beginning to end.

SANITARY EXAMINATIONS OF WATER, AIR, AND FOOD. A Handbook for the Medical Officer of Health. With Illustrations. By CORNELIUS B. FOX, M. D., M. R. C. P., London, Medical Officer of Health of East, Central, and South Essex; Fellow of the Chemical Society, etc., etc. Philadelphia: Lindsay & Blakiston, 1878. Price, $4.

THIS volume appears in response to a demand, by the scientific world, and especially of those engaged in the public-health service, for a third edition of the *brochure* on "Water Analysis." The author has rewritten nearly all he had before published upon the subject, and now offers the results of an increased and extended experience. He has also incorporated with his essay on "Water Analysis," sections on "Examinations of Air and Food." His aim is to furnish hints and suggestions, helpful to those who have not, like himself, "plodded for years through tortuous paths, at the sacrifice of much time and labor." In preparing the book, two objects were kept steadily in view: "1. To avoid a consideration of these three subjects, solely after the manner of an analyst, who mechanically deals with chemical operations and arithmetical calculations, but to treat them as a physician who studies them in connection with health and disease; 2. To render such details respecting examinations of water, air, and food, as fall within the province of the medical officer of health, so free from technicalities, and all cloudy and chaotic surroundings, as to enable any one, who possesses the average chemical knowledge of a physician, to teach himself, by the aid of this *vade mecum* of the health officer."

The following extracts will give a fair idea of the author's admirable directness of statement, and the valuable practical information he has been able to substitute for much of the technical detail that usually encumbers such a book:

An excess of aqueous vapor in the atmosphere has not only a depressing effect on the nervous system, but it interferes with the cutaneous and pulmonary exhalations. If the temperature is high (65° to 90° Fahr.), saturated air is sultry and offensive. If low (e. g., a Scotch mist of 36° Fahr.), its chilling influence penetrates all clothing. At least one half of the patients which apply for relief during the winter months to the physicians of the metropolitan and provincial hospitals of this country are afflicted with colds, coughs, and bronchial and rheumatic affections. The prevalence of these disorders at this season is, without a doubt, due partly to the coldness and partly to the excessive moisture of our very changeable climate. Above 80° Fahr., air of excessive humidity becomes injurious; and it has been doubted as to whether life can be prolonged in such air at a temperature between 90° and 100° Fahr.

The relation between such lung diseases as bronchitis and pneumonia and the unwholesome condition of the air of our dwellings has not been sufficiently recognized by the medical profession and the public. One of the most common causes of an attack of bronchitis is a sudden exposure of the bronchial mucous membrane to extreme conditions of air. A man who breathes for some hours the hot and dry vitiated air of an unventilated room is prone to be thus affected on passing out into cold, damp night air. If debilitated, from any cause, the inflammation may affect the substance of the lung, and the man will have pneumonia.

GENERAL VACCINATION. By ELISHA HARRIS, M. D. Cambridge: Riverside Press, 1877. Pp. 16.

IN this paper, Dr. Harris presents his well-matured views on the laws, sanitary provisions, and methods best fitted for securing the benefits of general vaccination throughout the United States. The same author, in another paper, suggests plans for securing complete and authentic records of deaths and the causes of death in this country.

CONSTITUENTS OF CLIMATE. By F. D. LENTE, M. D. From the "Richmond and Louisville Medical Journal," 1878. Pp. 56.

THE author of this pamphlet is a resident of Florida, and considers the "Constituents of Climate" with special reference to the climate of that State.

DEMOCRACY IN EUROPE. By Sir THOMAS ERSKINE MAY. 2 vols. New York: W. J. Widdleton, 1878. Pp. 495, 568. Price, $5.

THE progress of democracy, that is, of popular power, in European states, is a fact that is regarded with widely different emotions—some persons seeing in it unmixed evil, while others expect from it the solution of all the problems which vex the student of political science. The event will in all probability confound the adherents of both of these extreme opinions, and it will be found, after the last barrier to popular self-government has been removed, that the human race will still pursue the even tenor of its way. But, however this may be, the work before us treats of a living question, and is sure to win the attention of the thinking public.

Our author investigates the causes to which the progress of democracy in Europe is to be ascribed; how far it has contributed to good government; what have been its dangers and mischiefs; and for his illustrations he goes to the East, to Greece, to Rome, the middle ages, the Italian republics, Switzerland, the Netherlands, France, and England. The work is a series of studies of democracy in the countries named, and the author is careful not to call it a "History of Democracy in Europe," which would be simply another expression for a "History of Europe."

Of the work in general it may be remarked that it gives evidence of diligent research and abundant learning; also that it is written in a highly philosophical spirit. No homage is here rendered to *forms* of government, nor is the power of mere statutes and constitutions regarded as paramount in shaping the destinies of man in society. On the contrary, Sir Erskine May expressly investigates the *social*, *moral*, and *physical* causes of freedom, shows how the development of popular power is a *natural law*, considers the influence upon society and freedom of local environment, as the sea, navigable rivers, etc.; the influence of race; and many other factors usually overlooked by the Dryasdusts.

Hence we are the more surprised at the fact that he himself has overlooked one of the most easily discernible factors in the development of democracy in Europe. If we are

to believe the testimony of many not unintelligent observers, a very evident tendency to "Americanization" is everywhere visible in European life, and naturally this tendency would be apparent first of all in political life. Even in the quiet of the German universities "Americanization" is an ever-present specter. Yet in these two volumes little or no reference is made to the United States. True, the author says of the American Revolution that "it was a prelude to revolution in Europe"; that it "stimulated the popular movement in England and in France." But that is all. With Sir Erskine May the post-Revolutionary history of the United States goes for nothing, apparently, in so far as European democracy is concerned. Surely this is a fatal oversight in our author, and one that can not be repaired without rewriting the entire work.

THE NATIVE FLOWERS AND FERNS OF THE UNITED STATES. By THOMAS MEEHAN. Monthly Parts, each with Four Colored Plates. Boston: L. Prang & Co. 1878. 50 cents each.

WE have before us Parts VI. to XII. inclusive, completing the first of the two volumes of this valuable work; and, though we have noticed it before, we take occasion on the completion of Vol. I. to again commend it to the favorable attention of our readers. The text is a familiar account of the different flowers and ferns. Their associations with human history, wherever such associations have existed, are pleasantly recounted; the medicinal and household uses of each species receive attention; the botanical characters are clearly stated; in short, the purely literary portion of the work is of the highest excellence. As for the plates, it can be said of them without exaggeration that they leave nothing to be desired, whether with respect to their artistic beauty or their fidelity to nature.

THE RACES OF EUROPEAN TURKEY. By EDSON L. CLARK. New York: Dodd, Mead & Co. 1878. Pp. 532. Price, $3.

THE first of the three parts into which this work is divided contains a sketch of Byzantine history from the beginning of Justinian's reign down to the fall of Constantinople. The second gives an account of the modern Greeks and Albanians, their national characters, the state of religion and education among them, and their present condition and prospects. The third part is devoted to the Turkish Slavonians, the Wallachians, and the Gypsies, with sketches of the history of Servia, Bulgaria, and Montenegro.

REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION FOR 1877. Washington: Government Printing-Office. 1878. Pp. 500.

AMONG the most important papers contained in this report is one on "Color-Blindness in its Relation to Accidents by Rail and Sea," by Professor Holmgren, of the Upsal University. The author gives the history of color-blindness, and points out practical methods for discovering and determining defects of the sense of color. To this treatise is appended an article on "Color-Blindness" contributed to the "Princeton Review" more than thirty years ago by Professor Joseph Henry. There is a number of papers, by different authors, on American antiquities. Other essays in the report which are specially worthy of notice are: "Notes on the History and Climate of New Mexico," "Change of the Mexican Axolotl to an Amblystoma" (translated from the German), "Diminution of the Aqueous Vapor of the Atmosphere with Increase of Altitude" (translated from the French), together with several other short memoirs on meteorological subjects.

BULLETIN OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES. Vol. IV., No. 3, pp. 200; No. 4, pp. 140. 1878. Washington: Government Printing-Office.

THE contents of No. 3 include notes on the birds of Dakota and Montana, by Dr. Elliott Coues; on fishes from the Rio Grande, by Dr. D. S. Jordan; on the North American *Pyralidæ*, by Professor A. R. Grote; paleontological papers, by Dr. C. A. White; notes on fossils found in a dark shale discovered at Independence, Iowa, by Professor S. Calvin; and a paper on the mineralogy of Nevada, by Dr. W. J. Hoffman. No. 4 comprises a memoir by S. H. Scudder on certain fossil insects; a report by Dr. E. Coues on the fishes of Dakota and Montana; a catalogue of plants of the same region, by

the same author; remarks by Dr. F. M. Endrich on some striking products of erosion in Colorado; a paper on the Laramie group of rocks, by Dr. C. A. White; and finally a synonymatic list of the American Sciuri, by J. A. Allen.

OUR REVENUE SYSTEM AND THE CIVIL SERVICE, by A. L. EARLE; SUFFRAGE IN CITIES, by S. STERNE; PROTECTION AND REVENUE IN 1877, by Professor W. G. SUMNER; FRANCE AND THE UNITED STATES; FREE TRADE, by R. HAWLEY. New York: Putnam's Sons. 1878. 25 cents each.

THE titles of these publications sufficiently indicate their purpose—viz., to diffuse among the people information concerning the great economic questions of the time. The volumes constitute a series of "Economic Monographs," published under the auspices of the New York Free Trade Club.

THE STRENGTH OF MATERIALS, by W. KENT, M. E., pp. 140; HANDBOOK OF THE ELECTRO-MAGNETIC TELEGRAPH, by A. E. LORING, Practical Telegrapher, pp. 98; MAXIMUM STRESSES IN FRAMED BRIDGES, by Professor WILLIAM CAIN, C. E., pp. 192; GEOGRAPHICAL SURVEYING: ITS USES, METHODS, AND RESULTS, by F. DE YEAUX CARPENTER, C. E., pp. 176; TRANSMISSION OF POWER BY COMPRESSED AIR, by ROBERT ZAHNER, C. E., pp. 133. New York: Van Nostrand. 1878. Price, 50 cents each.

THESE latest volumes of Van Nostrand's series of brief treatises on subjects of practical science need no commendation. They are all written by men perfectly well versed in the subjects of which they treat, and the practical mechanician, electrician, surveyor, etc., will find in them precisely that kind and that measure of information which they most urgently need.

ZOÖLOGY OF THE VERTEBRATE ANIMALS. By ALEXANDER MACALISTER, M. D. Pp. 146. ASTRONOMY. By R. S. BALL, LL. D. New York: Holt & Co. 1878. Pp. 167. 60 cents each.

THE volumes named above are the first two, we believe, of a series entitled "Handbooks for Students and General Readers." Wherever it may appear to be desirable, the works are revised with special reference to the United States. Thus the volume on the Vertebrates is "specially revised" by Professor A. S. Packard, Jr., and the Astronomy by Professor Simon Newcomb. The editors and publishers of the series appear to have spared no pains and no expense to make the several volumes as perfect expositions as may be under the circumstances of the various departments of knowledge of which they treat.

TOTAL ABSTINENCE. By BENJAMIN WARD RICHARDSON, M. D., etc. London and New York: Macmillan. 1878. Pp. 119. 50 cents.

THE advocates of "prohibition" and "total abstinence" will derive great encouragement from the perusal of this little pamphlet: it contains the strongest arguments that can be advanced on the physiological side in favor of their views. Readers who are neither prohibitionists nor total abstainers would do well also to examine the matured opinions on the "wine question" of so eminent an authority as Dr. Richardson.

PUBLICATIONS RECEIVED.

Journal of a Tour in Marocco and the Great Atlas. By J. D. Hooker, K. C. S. I., etc., and J. Ball, F. R. S. London and New York: Macmillan. 1878. Pp. 515. $6.50.

Lectures on Materia Medica. By Carroll Dunham, M. D. New York: Printed by Francis Hart & Co. 1878. For sale at homœopathic pharmacies. Vol. I., pp. 409; Vol. II., pp. 419.

Natural History of the Agricultural Ant of Texas. By H. C. McCook. With Plates. Published by the Author. Academy of Natural Sciences, Philadelphia. 1879. Pp. 310. $4.

Lecture Notes on Chemical Physiology and Pathology. By Victor C. Vaughan, M. D. Ann Arbor, Michigan: Ann Arbor Printing and Publishing Co. 1878. Pp. 315.

The Great Slighted Fortune. By J. D. Bell. New York: T. Y. Crowell. Pp. 462. $1.50.

New and Original Theories of the Great Physical Forces. By U. R. Rogers, M. D. Published by the Author. 1878. Pp. 108.

Paradoxical Philosophy: A Sequel to "The Unseen Universe." London and New York: Macmillan. 1878. Pp. 235. $1.75.

Harmony of Science and the Bible on the Nature of the Soul. By J. U. Kellogg, M. D. Pp. 224. 75 cents.

Diphtheria: its Causes, Prevention, and Proper Treatment. Same Author. Battle Creek, Michigan: "Review and Herald" Publishing Co. 1879. Pp. 64. 25 cents.

Wanderings in South America. By Charles Waterton. London and New York: Macmillan. 1879. Pp. 536. $6.50.

Demonology and Devil-Lore. By Moncure Daniel Conway. New York: Holt & Co. 1879. Vol. I., pp. 444; Vol. II., pp. 482.

Native Flowers and Ferns of the United States. By Thomas Meehan. Boston: Prang & Co. 1878. Parts 17, 18, 19, 20. 50 cents each.

Index Medicus: Monthly Classified Record of the Current Medical Literature of the World. New York: Leypoldt. Vol. I., No. 1. Pp. 72. $3 per year.

Relation of Adhesion to Horizontal Pressure in Mountain Dynamics. By H. F. Walling. With Plates. From "Proceedings of American Association." Pp. 20.

On the Crystallography of Calcite. By J. R. McD. Irby. Bonn: Charles George print. 1878. Pp. 72.

Annual Report of the Health Officer of the District of Columbia (1878). Washington: Government Printing-Office. Pp. 117.

The Aphididæ of the United States. By C. V. Riley and J. Monell. With Plates from Bulletin of the United States Geological and Geographical Survey of the Territories. Pp. 32.

Report of the State Board of Health of Colorado (1877). Denver: "Tribune" print. Pp. 161.

Dictionary of Music and Musicians. By George Grove. London and New York: Macmillan. 1879. Part V. $1.25.

Industrial Education. By Alexander Hogg. Galveston, Texas: "News" print. 1879. Pp. 52.

Aural Therapeutics. By S. Theobald, M. D. From "Maryland Medical Journal." Pp. 10.

A New Order of Extinct Reptiles. By Professor O. C. Marsh. With Plates. From "American Journal of Science and Art." Pp. 8.

Some Early Notices of the Indians of Ohio. By M. F. Force. Cincinnati: Clarke. 1879. Pp. 75. 50 cents.

The Applications of the Physical Forces. By Amédée Guillemin. Part I. London and New York: Macmillan. 1879. Pp. 48. 40 cents.

Inequality in Length of the Lower Limbs. By William Hunt, M. D. From "American Journal of Medical Sciences." Pp. 6.

Are Inebriates Automatons? By G. M. Beard, M. D. From "Quarterly Journal of Inebriety." Pp. 12.

Address and Memorial in Opposition to the Bill to amend Statutes relating to Patents. Cincinnati: "Times" print. 1879. Pp. 76.

Inscribed Stone of Grave Creek Mound. By M. C. Reid. From "American Antiquarian."

Address of Professor A. R. Grote, Vice-President Section B, American Association. Salem: printed at the Salem press. 1878.

Report on the Walnut Hill Asylum. Hartford, Connecticut: Press of Case, Lockwood & Brainard Co. 1878. Pp. 26.

Silica vs. Ammonia: Report of Dr. A. R. Ledoux. Raleigh, North Carolina: "Farmer & Mechanic" print. Pp. 23.

A Fable of the Spider and the Bees. Compiled by the National Defense Association. New York. 1879. Pp. 61.

Hampton Tracts: Health Laws of Moses; Duty of Teachers; Preventable Diseases; Who found Jamie? A Haunted House. New York: Putnams. 1879. 8 cents each.

The Antiquities and Platycnemism of the Mound Builders of Wisconsin. By J. M. De Hart, M. D. Pp. 15.

On the Illumination of Lines of Molecular Pressure. By W. Crookes, F. R. S. London. 1878. Pp. 11.

Objections to the Doctrine of the Resurrection of the Body. By a Physician who has seen an Angel. Philadelphia: Gross & Halloway print. Pp. 21.

Alcoholic Medication. By N. Newby, M. D. Spiceland, Indiana. 1877. Pp. 16.

Extent and Significance of the Wisconsin Kettle Moraine. By T. C. Chamberlin. From Transactions Wisconsin Academy of Sciences. Pp. 36.

Yellow Fever. By J. Livingston. New Orleans: Hyatt print. Pp. 16.

Congress and the North Pole. By Captain H. W. Howgate, United States Army. Kansas City, Missouri: "Review of Science and Industry" print. 1879. Pp. 43.

Spencer's Social Anatomy. By H. M. Simmons. From Transactions Wisconsin Academy of Science. Pp. 6.

Thoughts on our Conceptions of Physical Law. By Professor Francis E. Nipher. Kansas City, Missouri: "Review" print. Pp. 9.

POPULAR MISCELLANY.

Printing and the Perpetuity of Modern Civilizations.—The subjoined remarks on the influence of printing on the permanency of our modern civilizations are from the able address delivered in August last before the American Association for the Advancement of Science, by Professor A. R. Grote, Vice-President of Section B:

Those who have brought together the story of the ancient civilization of Greece have agreed with unanimity that the separation between the mass of the people and the intellectual portion became at length insurmountable, and finally led to national destruction. This makes for our own view, that it was to a defect or incompleteness in the machinery for the dissemination of knowledge that we must ascribe the dying out of the older states. An intellectual aristocracy was established in Greece, which, in order to maintain its superior position, and thus, from natural and selfish motives, endeavored to prevent the spreading of new facts, but it was assisted in this action by the limitations which an ignorance of the art of mechanically duplicating writing threw around it. Philosophers have explained the fall of Greece, by considering it as a necessary step in the progress of humanity and the perfection of a future bloom of knowledge. And so in one sense it may be; but still exactly where the defect lay, and where there is a positive advantage in the conditions of modern civilization, and wherein modern civilization more adequately protects the state, have sometimes escaped them. To understand this fully we must

come back to natural history, to anthropology, at last. A large class of persons with a certain bias persistently decry our modern civilization, and look for its more or less speedy evanishment, merely because Rome perished and Greece decayed. But nowhere in nature is there exact repetition, and to understand the new civilization we must remember that it rests on a larger average intelligence, brought directly about by the discovery of the art of printing. There is then a distinct reason, a scientific ground, for the opinion that our present civilization rests upon a surer basis than did those which preceded it, and this we may safely bring forward in the cause of truth. For science is in danger always of being regarded as the enemy of the state, because it tends constantly to modify existing ideas. But if we can show the necessity for a constant modification of our ideas, arising out of our own constitution, then it may be seen to be unreasonable to defame those who follow the search for truth. And it being undoubtedly true, as Locke says, that, of all the men we meet with, nine out of ten are what they are, good or evil, useful or not, by their education, we can see how wide-reaching the effect of our improved basis of civilization must be upon us as a people, and how important it is to understand the real direction in which it works.

The Causes of Ocean-Currents.—An important contribution to the theory of ocean-currents is made by Professor Zöppritz, of the University of Giessen, who aims to show that these currents are produced by the impulsion of the winds. As Mr. Croll observes, in bringing Zöppritz's paper under the notice of English readers in "Nature," one of the main objections urged against this theory is that the winds can produce only a surface movement, while many of the ocean-currents extend to great depths. The reply to this objection is, that if the surface waters be impelled forward with a constant velocity by the wind or any other cause, they will drag along with themselves, though with a velocity somewhat less, the layer immediately below themselves. This second stratum now exerts the same influence on a third adjoining stratum, and sets it in motion in the same direction. The third stratum, in like manner, draws with itself a fourth, and so on. The propagation of this velocity is only bounded by the limits of the fluid itself. If these limits consist of a solid plane parallel to the strata, then the propagation of the velocity will cease only at that point, i. e., between the last liquid stratum and the first solid stratum. Among the results found, the author lays particular emphasis on two: "In the first place, the steady motion arising in the interior of an unlimited stratum of water from an unvarying surface velocity makes itself felt with linearly decreasing velocity down to the bottom. Hitherto the view frequently expressed was, that the influence of surface currents reached only to very moderate depths. Secondly, it was found that all variations according to time, whether periodic or aperiodic, of the forces acting on the surface, propagate themselves downward with extraordinary slowness, the periodic in very quickly decreasing amount. Taking both statements together, it follows that the movement of the chief part of the stratum of water exposed to periodically varying surface forces is determined by the mean velocity of the surface, and that the periodic variations are observable only in a comparatively thin surface stratum."

Population-Density and Rates of Mortality.—Some curious and interesting results are developed by Dr. Farr, F. R. S., from a study of the rate of mortality in connection with statistics of population-density. He finds that the rate of mortality increases as density of population increases, and this he proves by arranging the 619 districts of England and Wales in groups according to the rates of mortality, and showing that all the groups follow this law. Thus in the ten years 1861–'70, at one end of the scale the deaths per 1,000 of population are 15, 16, and 17; at the other end, 31, 33, and 39. The acres *per capita* in the corresponding districts are 12, 4, and 3, and 1·01, ·05, 1·01. The intermediate rates of mortality are 18, 19, 20, 21, 22, 23, 24, and 25, while the acres *per capita* are 4, 3·3, 2·9, 2·1, 1·1, ·05, and ·02. Now, excluding the London districts, about which there is some difficulty, we have 7 groups of districts where the mortality ranges thus: 17, 19, 22, 25, 28,

32, and 39. In the same districts the number of persons to a square mile is 166, 186, 379, 1,718, 4,499, 12,351, and 63,823. Thus, in Liverpool, the densest and the unhealthiest district in England, there were 63,823 to an acre; of whom 39 per 1,000 died annually. This series of facts may be put in a different way: The nearer people live to each other the shorter their lives are. Thus the proximity of people in 53 districts is 147 yards, the mean duration of life is 51 years; in 345 districts the proximity is 139 yards, and the mean duration of life is 45 years; in 137 districts the proximity is 97 yards, and the mean duration of life is 40 years; in 47 districts the proximity is 46 yards, and the mean duration of life is 35 years; in 9 districts the proximity is 28 yards, the mean duration of life is 32 years. In Manchester district the proximity is 17 yards, and the mean duration of life is 29 years; in Liverpool district the proximity is 7 yards, and the mean duration of life is 26 years. This is a determined law, and, the duration of life being given in one set of conditions, the duration of life in another set of conditions is determined from the proximities.

An Interesting Collection of South American Fossils.—Prof. Cope bought the collection of fossil bones from the Argentine Confederation which were brought to show at the Paris Exposition. Several countries are said to have wanted them. They will be of value in this country, because the chief portion of them are not to be found anywhere in the United States. They come from Patagonia, and the collection includes about one hundred and fifty specimens of animals. There are nineteen skeletons, chiefly of large animals, almost completely whole, among which are armadilloes and sloths. One of the armadilloes has a curious tail which increases in size toward the end, at which point it takes an oval shape and is from a foot to eighteen inches wide. Unlike that of all other armadilloes, it is without joints, except that at the base. It is supposed to have been a fighting weapon. Another rare specimen is a sabre-toothed tiger, of which there is only one other known specimen in the world. The size of the sloth skeletons varies from that of a small black bear to the largest elephant. The sabre-toothed tiger and the club-tailed armadillo are supposed to have been monarchs of the forests in their day. It has not yet been determined to what institution of science the collection is to be presented.

Artificial Diamonds.—In examining the papers of their deceased father, J. N. Gaunal, Messrs. A. and F. Gaunal found one which purported to be a copy of a memoir presented by him to the Paris Academy of Sciences in 1828, and which gave an account of a process for the artificial production of diamonds. The Academy simply buried the communication in its archives, and never mentioned it in any way. The substance of this document is now published in "Le Monde de Science et de l'Industrie," from which we take the following particulars: Equal weights of carbon sulphide and of phosphorus, both as pure as possible, are put in a flask, and a little water added which floats on the top and prevents the sulphide from turning to vapor and from taking fire. The whole having been placed in some situation where it will not be disturbed, the sulphur of the sulphides combines with the phosphorus and releases the carbon, which falls to the bottom and assumes a crystalline form. This result takes place slowly, and not till after the lapse of six months was M. Gaunal able to obtain diamonds the size of a grain of millet-seed. As for the purity of these small diamonds it was proved by the strictest tests, and that not only by M. Gaunal but also by others. The experiment was repeated several times in the course of many years by M. Gaunal, and always with the same result. The artificial diamonds consist of pure carbon in dodecahedral crystals, and they scratch steel like the natural diamond.

Protection of Iron Surfaces from Rust.—We have already briefly described Professor Barff's method of rendering the surface of iron unoxidizable, yet, by way of introducing some remarks on the results of the process published in the "Lancet," we may repeat that it consists merely in subjecting the iron to the action of superheated steam—steam having a temperature of 1500° Fahr. This steam is generated in an upright boiler, and is then conducted through

the "superheater," which imparts to it the necessary temperature. The iron articles to be acted on are placed in a chamber built of fire-clay, and the steam being admitted to it a coating of magnetic, or black, oxide of iron is produced on the surface. And now for the result. The article has a dull-black appearance, and is susceptible of a high degree of polish. The surface coating is absolutely adherent, and is so hard that it is not removable by ordinary methods, for instance, an iron rasp has no effect on it; and the same is to be said of all the agents which under ordinary conditions oxidize iron. Salt or fresh water, vegetable acids, and even the London atmosphere, are unable to produce the slightest tarnish. Iron vessels which have contained water for weeks are entirely free from rust. Iron piping and ornamental castings, which have for months lain among the wet leaves in the garden outside Professor Barff's laboratory, are unchanged. The cost of the process is trifling, less than that of "galvanizing." The sanitary and domestic uses of iron thus prepared are numerous, as for water-pipes and cisterns and for cooking apparatus.

Plants and Atmospheric Humidity.—Two questions of considerable interest, viz., that of the effect of living plants on the atmosphere of houses and that of the relations between forests and atmospheric humidity, appear to have no little light thrown upon them by the ingenious researches of Dr. J. M. Anders, published in the "American Naturalist." We can not state with any degree of fullness the author's experiments to determine the amount of vapor transpired by plants in proportion to the area of their leaf surface. Suffice it to say that according to these experiments the "Washington elm," at Cambridge, Massachusetts, with its 200,000 square feet of leaf surface, would transpire seven and three quarter tons of watery vapor in twelve diurnal hours of clear weather. Carrying the calculation further, a grove consisting of 500 trees, each with a leaf surface equal to that of the elm mentioned, would return to the atmosphere 3,875 tons of aqueous vapor in twelve hours. In-doors, transpiration is during the day only about one half as active as in the open air, but at night it is about equal in the two situations: hence the transpiration of a plant in-doors is more than one half as much in twenty-four hours as it would be outside. It follows that growing plants increase the humidity of the atmosphere in a closed room. This point is very important where rooms are heated by hot-air furnaces. In such apartments the air is drier than in apartments heated by a stove or an open fireplace. In a dry atmosphere of the temperature of 65° to 68° Fahr. a great demand is made upon the system to supply the air with moisture, the skin and pulmonary mucous membrane are dried, and a condition is induced which is expressed in irritability of the nervous system, paleness and susceptibility of the skin to cold, liability to pulmonary diseases, and, in short, deterioration of all the functions. Now, if the presence of a certain number of thrifty plants in an occupied apartment, warmed by dry air, would have the effect of raising the proportion of aqueous vapor, it is clear that plants in rooms heated by a hot-air furnace would, in an hygienic point of view, be of very decided value, since they may become the means of obviating very distressing symptoms, or even disease itself. As for the question of the relation of forest-growth to atmospheric humidity and consequently to rainfall, such relation would appear to be clearly established by the author's researches.

Source of Organic Matter in Igneous Rocks.—Associated with the sheet of trap-rock which forms the First Newark Mountain, New Jersey, there occurs near Plainfield an amygdaloid trap passing into a metamorphosed shale. Many of the cavities in the amygdaloid rock are filled with a jet-black carbonaceous mineral, closely resembling the "albertite" of New Brunswick. Above the amygdaloid is a metamorphosed shale, traversed by seams and fissures, which are frequently filled with the same albertite-like mineral. Finally, resting on these metamorphosed beds are slates, shales, and sandstones, which contain fossil fishes and an abundance of obscure vegetal remains. From this state of facts Mr. J. C. Russell ("American Journal of Science" for August) infers that the organic bodies in the

uppermost strata furnished by their decomposition the carbonaceous material in the associated rocks, the heat derived from the slowly-cooling injected rocks playing an important part in this process. Similar deposits of carbonaceous mineral in igneous rocks are found in other localities, as at Cape Gaspé, and in the lava of Mount Etna, though in these cases it occurs in the less concentrated form of mineral oil. But Mr. Russell sees in these different forces only different stages of one and the same process. "If," he writes, "the cavities of a rock were filled with petroleum by infiltration, and evaporation slowly removed the more volatile portions, and oxidation took place to some extent, the result would be the formation of a deposit of solid hydrocarbon in the cavities. A similar process sometimes occurs with bottled samples of petroleum, by which the interior of the bottle is left coated with a solid carbonaceous layer. In the rocks, if a fresh supply of oil were furnished from time to time by infiltration, the cavities would eventually become completely filled with the solid carbonaceous residue. A vesicular lava might in this manner be changed to an amygdaloid, the cavities of which would be filled with solid hydrocarbons instead of quartz, zeolites, etc. Such, it appears to us, must have been the history of the Triassic amygdaloid we have described, the cavities of which must at one time have been filled with mineral oil. This is but an epitome of what took place on a grand scale at the great fissure, over 1,400 feet deep, in New Brunswick, which was filled with albertite, and in the case of the Grahamite in West Virginia, which also occupies an immense fissure."

Whence came the Arctic Mammoth?—Were the mammoths whose remains are found in the north of Siberia native in that region, or were they carried thither by rivers from a more genial climate? If the latter supposition were correct, we should find the remains only in the vicinity of the great watercourses, while, in fact, they occur in localities distant from the beds of streams. But here fresh difficulties face us, for, though the mammoth was covered with a thick coat of long hair, how could it live in a region where the temperature in January is as low as 65° Fahr., where the summer lasts only three or four months, and where the vegetation is exceedingly scanty? The supposition is plainly inadmissible, and hence either we must believe these remains to have been transported hither, or else that in early times the climate of Siberia was much less severe than it is at present. Nor is this a baseless theory, for, as Mr. U. H. Howorth observes, the plants found in the fissures of the rhinoceros-teeth (contemporary with the mammoth) are those which now live in southern Siberia. The plant-remains associated with the mammoth (not floated from a distance, but of the locality) show the same thing, the species being larch, birch, and other trees of good size. Other evidences of the existence of a higher mean temperature in Siberia at the time of the mammoth are found in the fresh-water and land shells associated with the remains, but now extinct in northern Siberia. As for the manner of the mammoth's extinction, Mr. Howorth believes it to have been sudden. The remains must have been preserved soon after death. They were destroyed by a flood due to some sudden convulsion, which also changed the climate.

Civilization and Teeth.—From the study of 1,249 skulls, of which 844 represent modern highly civilized races, and 277 modern inferior races, while the remaining 128 belonged to Romans, Etruscans, Phœnicians, and other nations of antiquity, Professor Mantegazza reaches conclusions which go to confirm a remark made by Mr. Darwin in "The Descent of Man." "It appears," writes Darwin, "as if the posterior molar or wisdom teeth were tending to become rudimentary in the more civilized races of man." Professor Mantegazza finds that the wisdom-teeth are more frequently absent in the superior than in the inferior types, the exact proportion being 42·42 per cent. in skulls of the higher races against 19·86 in the lower. But atrophy of the third molar tooth occurs less frequently in the higher than in the lower races, viz., in 10·90 per cent. of the former, and in 20·58 per cent. of the latter. In the lower races the abnormal cases are practically equal to the normal, while in the higher they are much

more numerous, the proportion being 62·91 per cent. to 37·09 per cent. Mantegazza is inclined to suppose that at a period more or less remote the third molar will disappear from the human jaw.

A New Plant.—A botanical discovery of considerable interest is announced in a letter, written by Dr. Beccari, from Sumatra. It is a gigantic aroid, which can only be compared with the Godwinia discovered by Seewann in Nicaragua. Dr. Beccari is as yet unable to determine the genus, but he believes it to be a *Conophallus*. The tuber of one plant was 1·40 metre in circumference, and two men were hardly able to carry it. From the tuber, as in the genus *Amorphophallus*, only one leaf is produced, which in form and segmentation does not differ much from that genus. But the dimensions are very different indeed. The stalk at the base in one instance was 90 centimetres in girth, was slightly less at the apex, and reached the height of 3·5 metres; its surface was smooth, of a green color, with numerous small, white dots. The three branches into which it was divided at the top were each as large as a man's thigh, and were divided several times, forming altogether a frond not less than 3·1 metres long. The whole leaf covered an area of 15 metres circumference. The spadix of a plant found in fruit had the stalk-dimensions just given; the fruit-bearing portion was cylindrical, 75 centimetres in girth, 50 centimetres long, and was densely covered with olive-shaped fruit 35 to 40 millimetres long, and 35 millimetres in diameter, of a bright-red color, each containing two seeds.

Advantages of Oral Teaching.—It would not be easy to compress within equal space a greater amount of practical common sense than we find in a recent communication entitled "Our Schools," printed in "The Examiner." "I believe," writes the author, "that one of the great stumbling-blocks to boys is want of oral teaching, in a popular style, particularly among little boys. It is a notorious fact that the grown-up world generally learns geography and history by means of newspapers and reading accounts of current events with the aid of the maps which are published from time to time for the purpose, and, if boys were taught in the same popular manner at the commencement of their education, it would do lasting good. We must all remember the dreary toil of mastering geography by learning a quantity of details out of a book about the number of inhabitants, names of rivers, the trade, the religion, and manners and customs of any country, without any means of impressing facts on the mind, while history becomes a positive treadmill when left to a boy's private reading. When the Prince of Wales went to India, if any one with an attractive manner of talking had taken a series of cartoons simply showing the rivers, the principal cities and mountain ranges, and some of the pictures published in the illustrated papers, he could, by arousing deep interest, have made the way easy for acquiring a fuller, more complete knowledge. The same mode of teaching would apply to the late European wars, the Indian famine, or any other great national event or calamity. We do this kind of thing in business matters every day of our lives in committees, on trials, and in all important transactions. It should be the same with boys; they should be interested in their subject before being set to master its drier details, which would, by this very introduction, lose much of their dryness."

Retentive Memories.—A number of instances of great retentiveness and accuracy of memory are recorded by a writer in "Chambers's Journal." Among the names mentioned is that of Dr. Robert Chambers, whose power of memory was very extraordinary. For example, on a certain occasion he was heard to say, "This day forty-seven years ago, at twenty minutes past two o'clock, I was passing" such a number of such a street, and met such and such a one. The author finds in Sir Walter Scott and in Charles Dickens a like accuracy of memory, and to this attributes no small share of their success as story-writers. Then a case is cited from one of Dr. Carpenter's writings of a clergyman who, on visiting Pevensey Castle, felt convinced he must have seen it before, and that when he did there were donkeys under the gateway, and some people on top of it. On inquiry he ascertained that he had been there with a picnic party, who made the excursion on donkeys, when

he was only about eighteen months old. Sometimes the whole history of a lifetime will be flashed before the mind as in an instantaneous picture. That this occurs sometimes when death, or peril of death, is imminent, is quite certain. It may be that this occurs very frequently before actual death; but this we cannot know, as all the instances of which we have accounts are those in which a man has described his sensations after having been saved from dying —especially from drowning. "When all hope of being saved is gone," says the author, "and the very struggle with the water is now made without conscious effort, it would seem that, without being prompted by the will, the memory suddenly grasps at once the deeds of the life that now appears about to close, and at the same time —and this is the most singular fact of the phenomenon—recognizes the usual rectitude or wrong of each act [?]. There is," he continues, "a case of this kind recorded of an English naval officer, who thus remembered the events of his life at the moment when he was struggling hopelessly in the wake of the ship from which he had fallen; and he confessed that he had been especially struck by the sudden coming into his thoughts of a schoolboy lie that he had long forgotten."

Economic Statistics of the World.—A general review of the economic statistics of the world in 1877 is published by Professor Neumann Spallart, of Vienna; from it we take the following statements:

Railways.—In the last three decades the network of European railways has risen from 9,000 kilometres (5,580 miles) in 1847 to 154,200 kilometres[1] (95,604 miles) in 1877. Of these 154,200 kilometres 27,500 are in Great Britain and Ireland; 24,800 in Austro-Hungary; 23,400 in France; 18,000 in Russia; 30,000 in Germany. The remainder is distributed among the smaller states. According to these figures Europe has 150 kilometres of railway for each thousand square kilometres and 4·8 kilometres per 10,000 inhabitants. These ratios are exceeded in Belgium, Great Britain and Ireland, Switzerland, the Netherlands, etc.

[1] One kilometre is about ⅝ of a mile.

America.—In 1830 the United States had 42 kilometres of railway; now they have 128,000 kilometres (79,360 miles), or 133 kilometres for every 1,000 square kilometres of surface, and 28 kilometres per 10,000 inhabitants. In the remainder of this continent there are 17,000 kilometres of railway, of which Canada has 7,000.

In India and Ceylon there are 11,000 kilometres, or 46 kilometres per 1,000 square kilometres of area and ¼ kilometre per 10,000 inhabitants. In Africa there are 2,800 kilometres, whereof 1,800 belong to Egypt. Australia and New Zealand possess 4,000 kilometres of railway.

On all these railways are employed 62,000 locomotive-engines, 112,000 passenger-carriages, and 1,500,000 freight-cars; they annually carry 1,150,000,000 passengers, and 16,000,000,000 quarters of freight.

Marine.—The merchant marine of Europe embraces in all 7,400 ocean steamships with a tonnage of 3,000,000 tons, of which totals the United Kingdom contributes 5,200 steamships and over 2,000,000,000 tons of freight.

Telegraphs.—At the beginning of 1877 Europe had 351,000 kilometres of telegraph lines, whereof 65,000 belonged to Russia, 54,000 to France, 48,000 to Germany, 40,000 to the United Kingdom. America had then 183,000 kilometres. The dispatches sent over European lines numbered 82,000,000 in 1876; those sent over American lines amounted to 23,000,000. Asia and Australia have each 38,000 to 39,000 kilometres, transmitting 2,500,000 dispatches. In Africa there are only 15,000 kilometres, almost exclusively in Egypt, Algiers, and Tunis, and the number of dispatches sent is 1,200,000. There are 560 submarine cables, representing a total length of 65,000 nautical miles.

Postal Service.—The postal service now extends to the uttermost bounds of civilization, embracing the whole globe, from Hammersfest to New Zealand.

In Europe over 3,000,000,000 letters and postal-cards are carried yearly. In this total the United Kingdom is represented by over 1,000,000,000; Germany by 700,000,000; France by 366,000,000; Austro-Hungary by 300,000,000; Italy by 120,000,000. This would give for England 33 letters per

head of the population; for Switzerland, 24; Germany 15; France 10. Turkey figures for only 0·2 of a letter *per capita*. In America the number of letters and postal-cards carried was 700,000,000; in Asia, 150,000,000; in Australia, 50,000,000; in Africa, 25,000,000.

Gas-Stoves and the Products of Combustion.—City people are wont to express their surprise at the stupidity of the countryman who extinguishes a gaslight by blowing it out, and then sleeps in the same room. Yet the same acute city people will set up a gas cooking-stove, and will never think of the necessity of carrying away the products of combustion. Plainly, in view of the prospective large employment of carburetted hydrogen gas as a domestic fuel, it behooves the sanitarian to emphasize the necessity of proper regard for sanitary requirements. The public will have to be instructed in the simplest elements of science, and drilled to heed the plainest teachings of every-day experience, or else the general introduction of gas as a fuel will at first occasion a fearful amount of mortality. The observations of the editor of the "Lancet," in a house in the "West End" of London—the fashionable quarter of that metropolis—might be repeated any day in the "best quarter" of our American cities. The editor of the "Lancet" visited the kitchen of the house in question, having been asked to give an opinion as to the wholesomeness or otherwise of the cooking arrangements. He found a gas hot-plate with five circles of burners, each circle having 12 or 15 jets, so that when the hot-plate was fully heated 60 or 80 jets were in active combustion. Each jet produced about two cubic feet of carbonic acid per hour, a total of 120 to 160 cubic feet, in addition to sulphurous acid. No chimney was provided for the escape of the gas, and the very intelligent inmates of the house could not understand why the cook looked so pale and ill; as for the cook herself, though she often felt "giddy and fit to fall upon the floor," she never suspected the gas-stove! Now, since each of the gas-jets had an effect equal to the respiration of one human being, it is evident that the population of that kitchen practically amounted at certain times to sixty or eighty persons; and the exhalations from this "black hole" had no way of escape except through the kitchen door and into the house. This instance of the stupidity of "intelligent" people is so typical that it deserves to become "classic."

Effects of a Diet of Shingle-Nails.—The cows of a large dairy-farm in Hungary having been all simultaneously seized with disease, the symptoms being high fever, difficult respiration, and inflation of the body, it was determined to slaughter two of them and to make an examination of the bodies. The organs of the chest appeared perfectly normal. On opening the stomach its contents were found partly fluid and partly of pappy consistence, and among this matter were discovered a number of shingle-nails of various lengths, some of them free, and others partially imbedded in the walls of the stomach. Renewed investigation cleared up the mystery as to how these nails got there. About a year before, a shed on the estate caught fire, and the shingles of the roof were torn off, nails and all, in the attempt to put out the flames. In the winter the damaged materials were burned in the farm-buildings as fire-wood, the ashes subsequently strewed upon a clover-field, and the nails contained in the latter unfortunately were raked up with the hay crop obtained from it in the following summer. Every cow upon the farm had to be slaughtered, and in every case nails were found in the second stomach.

The Electric Light as a Source of Nitric Acid.—It is known that, when combustion takes place at high temperatures, small quantities of the nitrogen and oxygen of atmospheric air combine, forming several oxides of nitrogen, many of which are strong, corrosive acids. This is the case when electric sparks are passed through air, also during combustion in air of hydrogen. It therefore appears probable that, as the temperature of the electric arc is undoubtedly very high, nitric acid, or some other oxide of nitrogen, might be produced by the electric light. This subject has been investigated experimentally by Mr. T. Wills, with results strongly confirmatory of this theo-

retical inference. The first experiment was rather surprising. A glass cylinder placed over an electric lamp (Foucault's regulator) for two minutes, and afterward examined, was seen to contain a perceptible amount of red fumes, due to peroxide of nitrogen (N_2O_4). The air surrounding the lamp was next drawn through a solution of potash, and the amount of nitric acid estimated; this gave ten to twelve grains of nitric acid produced per hour, (it may eventually prove to be more, the difficulty being to collect the whole of it). The next step in the research will be to examine the various forms of electric light, with a view to determine the amount of nitric acid produced by each.

In an Ants' Nest.—The columns of the Popular Miscellany from month to month give evidence of the interest with which naturalists study the ways of ants. Indeed, the life-history of that interesting insect seems to be full of surprises for the persevering observer. Here is an account of a nest of *Formica nigra*, in which a number of Termites were kept as slaves. While entomologizing in Portugal in 1877, in the neighborhood of Cintra, Mr. Henry O. Forbes found a nest of *F. nigra* under a stone. On turning the stone over, he observed great consternation in the community, evidently caused by the fear lest a colony of *Termes lucifugus*, which the Formicas had enslaved, should escape. The Nigras instantly began seizing the Termites, driving them underground by the nearest orifices, in the mean time wrenching and pulling off their wings. In the nest there was also a large number of Termite larvæ, and the great object of the Nigras seemed to be to get these underground as speedily as possible. The ants fell on them with fierce impetuosity, seizing them anyhow and anywhere, dragging them against the most strenuous opposition into the nearest apertures of the underground home. Very often this opposition resulted in a long and savage fight, in which the larvæ were badly wounded, being deprived sometimes of their antennæ, sometimes of half their jaws, and not seldom killed outright. Occasionally, however, the larvæ were victorious, beating off the Formicas. The observer saw at the end of a long fight one larva drawn by its antennæ, while it strenuously held on to a small ball of earth which had proved a vain anchorage for its feet, for larva and clod together were dragged for a long distance through the grass. At last it seized one stalk so firmly that its enemy could not drag it farther; whereupon, after reconnoitering the ground for a little distance, the latter disappeared, but shortly returned with a companion, by whose aid the larva was detached. This done, the helper went his way, while the abductor proceeded with his captive till lost to view.

Pearls and their Origin.—People are still to be found who believe in the myth which ascribes to pearls a sort of animal nature—being born of other pearls, feeding like other animals, and growing larger by the conversion of food into their own substance. A glass tube purporting to contain some of these growing pearls and certain "grains of rice," on which they fed, was lately sent from Australia to Mr. Frank Buckland, who in turn placed it in the hands of a competent conchologist, Mr. Hugh Owen, for examination. Mr. Owen, honestly desirous of dissipating the crass ignorance which alone makes belief in such absurdities possible, takes the trouble to state briefly, in "Land and Water," the natural history of pearls, in substance as follows: Pearls are concretions found either attached to the interior of certain bivalve shells, or enveloped in the folds of the mantle of the animal that inhabits the shell; the latter are most valued. All pearls are formed of the same substance as that lining the inner surfaces of the shells in which they are formed. The peculiar luster is caused by alternate layers of thin membrane and carbonate of lime, and depends on very minute undulations of the layers. The most valuable pearls are found in the soft portions of the mollusca, and are believed to be originally a grain of sand, or some other irritating substance, which the animal covers with a nacreous deposit. That this is the correct theory is seen on cutting or slitting pearls, when each one is found to have a foreign body as a nucleus. Such being the natural history of pearls, the story of "young pearls feeding on rice"

should not be heard outside of the nursery. It may be added that the "rice-grains" in the collection presented to Mr. Buckland are identified by Mr. Owen as marine shells of the genus *Cypræa*, the end or apex of each being carefully filed or ground off to represent the effect of having been fed on by the pearls.

Survival of Serious Brain Injury in a Pigeon.—A remarkable case of recovery of all the faculties in a pigeon from which four fifths of the upper portion of the cerebrum had been removed, is recorded by Dr. J. H. McQuillen, in the "Proceedings" of the Academy of Natural Sciences of Philadelphia. The author, who is Professor of Physiology in the Philadelphia Dental College, on February 4th of last year, exposed the cerebrum of a pigeon, and cut out four fifths of the upper portion in slices: this he did in illustrating to his class the fact that the sensorium thus exposed could be cut, pinched, or burned, without any sign of pain on the part of the animal. The usual phenomena followed, viz., profound stupor, the bird standing motionless on the table, with eyes closed, head sunk between the shoulders, and feathers ruffled. At the close of the demonstration, this pigeon was given to Professor Emily White, M. D., of the Women's Medical College, with the request that an effort should be made to keep the bird alive, and ascertain whether the mutilated organ would regain its functions. In March a note was received from Professor White, in which she stated that the pigeon had apparently recovered all its faculties. "He is," it was added, "perhaps less excitable than normal, and seems perfectly tame, but bright." Dr. McQuillen at once sent for the bird, and observed with surprise the complete recovery of the voluntary movements of walking and flying, the power of feeding itself and drinking as usual, and the general manifestations of intelligence. The bird continued in full possession of its faculties for six months, and then was put to death and an examination made. On removing the scalp a fibrous structure, analogous to pericranium, was found, occupying the place from which the bone had been removed in making the vivisection. Cutting this away, a small amount of fluid escaped, and the cranial cavity thus exposed was found occupied by a white substance resembling the cerebral structure that had been removed six months before. Placing a section of the upper portion of this, which had been stained with hematoxyline, under the microscope, a number of bipolar cells characteristic of the gray structure were observed.

Pigments of the Hair.—By treating with dilute sulphuric acid different kinds of human hair, Mr. H. C. Sorby obtains three distinct pigments, a red, a yellow, and a black. The red pigment is probably convertible by oxidation into the yellow. Very red hair is characterized by the presence of the red constituent unmodified by any other coloring substance; golden hair has less of the red and more of the yellow pigment; in sandy-brown hair the black and red constituents are associated with a large proportion of the yellow; in dark-brown hair the black pigment is present in larger quantity, while in black hair this dark substance predominates over the rest. Singularly enough, Mr. Sorby found in the hair of a negro about the same proportion of the red pigment as in the very red hair of a European. If in this case the development of the black pigment had been checked by any cause, he would have presented the curious spectacle of a red-headed negro.

Wallace's Theory of Zoölogical Derivation.—To illustrate Wallace's theory of the derivation of all animals from the north, a writer in "Nature" designed a map of the world on a polar projection, the northern hemisphere being projected somewhat beyond the southern tropic. This map clearly shows how the land-surface of the globe is built around the pole, and exhibits the extremities of America, Africa, and Australia, extending into the great ocean. If, now, the subdivisional regions (zoölogically) of each of these three great projections, and of the whole, be marked in colors, a succession of zoölogical strata (so to speak) appears. By carrying an ideal section from the supposed center of creation in the north through either of these three great extremities, and thence to the nearer and afterward the more remote of their dependencies, we pass in

each case through zoölogical strata of different types, until we arrive at those where no land mammals are to be found at all. And this succession in space, as evidenced by geography, corresponds in a rough way with the succession in time as revealed by geology: 1. As we recede in distance, we meet with increased dissimilarity. 2. This dissimilarity partakes of a recession in type. 3. Some of these geographical districts seem to have their counterparts in geological periods. The Ethiopian region, as Wallace has shown, presents us with the exiled Miocene fauna of Europe. Eocene forms may be seen in its dependency of Madagascar. Highly isolated Australia, with its marsupials, etc., appears as if it were still in the secondary age. Oceanic islands, such as New Zealand, give no land mammals at all. In others, the reptiles "possess the land."

Antiquity of the Practice of Inoculation.—Inoculation as a means of mitigating the severity of small-pox was practiced in Eastern countries ages before its introduction into the West by Lady Mary Wortley Montagu. The Chinese appear to have practiced it as early as the sixth century. Small-pox is by the Chinese called "heaven's flowers," and their term for inoculation is "cultivating heaven's flowers." Their mode of procedure is to pulverize the scabs taken from a small-pox patient, and to blow the powder thus obtained up the nostril of the child. The powder is injected into the left nostril in the case of a boy, and into the right in the case of a girl. It is impossible to tell whether the disease induced will be severe or not. In some years there are few if any deaths, at other times the mortality is much the same as that from small-pox. A lucky day is carefully chosen for the operation, and at a time when the child is in good health. No particular rules are observed in selecting the matter, except that it is always taken from a mild case of the disease. Gradually, however, vaccination is coming into use in China. The suspicion with which vaccination was formerly regarded by the people as a subtle device of the foreigners to destroy the inhabitants of the Central Flowery Kingdom is dying out, and Dr. Osgood, of Foochow, who has every opportunity of knowing, says that "vaccination is gaining ground every year, and is destined in time to drive out inoculation." But the process of substitution must necessarily be very slow in so strictly conservative a country as the Chinese Empire.

NOTES.

Among the results of the labors of the United States Fish Commission during the year 1878 is to be reckoned the discovery of fifty new species of fishes in our Atlantic waters. These species are enumerated by Messrs. G. Brown Goode and Tarleton H. Bean, in the "American Journal of Science." Full descriptions of the fishes, with discussions of sundry questions of classification, will appear in the publications of the United States National Museum.

A new danger to health is found in the use of artificial flowers colored with aniline dyes. The bronze-green and other colors now so much in vogue are not "fixed," and the dye is apt to be transferred to the skin of the head, producing much annoyance, unpleasant irritation, or even inflammation.

Professor Leidy, having examined with the microscope a "black mildew" found growing on brick walls in shaded situations, found it to be a species of *alga* closely allied to *Protococcus viridis*, which gives the bright-green color to the trunks of trees, fences, etc. The species which produces the black discoloration may be only *viridis* in a different state, but, until it is proved to be such, he proposes to distinguish it by the name of *Protococcus lugubris*. The latter consists of minute round or oval cells, from 0·006 to 0.009 millimetre in diameter, isolated or in pairs or in groups of four, the result of division; or it occurs in short irregular chains of four or more cells up to a dozen, occasionally with a lateral offset of two or more cells. In mass, to the naked eye, the *alga* appears as an intensely black powder.

In certain districts of Austria where cretinism exists the skulls of the wretches who have been afflicted with that disease are disinterred a few years after death and preserved by their nearest relatives. A like custom prevailed in Peru in times prior to the discovery of America, as we learn from an article in "La Nature," on the Anthropological Exposition lately held in Paris. Two crania were there exhibited, one of them overlaid with gold and the other with silver. The evidences of cretinism in these skulls are unmistakable, and there can be no doubt that they were at one time objects of pious care. The custom in Austria is to

write the name of the deceased cretin across the forehead of the skull, to paint a fillet of leaves and flowers around the latter, and to engrave on it different emblems, as crosses and the like.

When the committee of scientific men who had been charged with the organization of the Anthropological Exposition connected with the Paris World's Fair called on M. Krantz, the Director-General, to obtain his approval of the plan, his reply was: "Gentlemen, I must confess that I have never heard anything but evil about you. This has satisfied me that your work is of value; this has led me to infer that it is useful, and has given me a bias in its favor."

To test the correctness of the statement which has been made that the leather covers of books in libraries are injured by the combustion products of coal-gas, Professor Wolcott Gibbs has examined the books in different libraries, in some of which gas is burned, in others not; and his conclusion is that the effects supposed to be attributable to the burned gas are in reality due to other causes. The trouble is more probably in the tanning of the leather than in the action of the gas; the older kinds of leather used by binders being of poor quality and badly tanned.

In 1871 a vessel laden with Italian marble was wrecked off Long Island. Specimens of this marble, presenting certain very interesting appearances, having been presented to the Peabody Museum of Yale College, they are described in the "American Journal of Science" by Professor Verrill. The exposed portions of the slabs are, he says, thoroughly penetrated to the depth of one or two inches by the crooked and irregular borings or galleries of the sponge *Cliona sulphurea* (V.), so as to reduce it to a complete honeycomb, readily crumbled by the fingers. Beyond these borings the marble is perfectly sound and unaltered. Professor Verrill has long been familiar with the fact that this sponge can destroy the shells of oysters, mussels, etc., but this is the first instance he has noticed of its attacking marble or limestone, for calcareous rocks do not occur along the portions of our coast inhabited by it. Its ability to rapidly destroy such rocks might have a practical bearing in case of submarine structures of limestone or similar material.

"Blasting gelatine," a new explosive agent, is formed by dissolving collodion cotton in nitro-glycerine in the proportion of 10 per cent. of the former to 90 per cent. of the latter. The product is a gelatinous, elastic, transparent, pale-yellow substance, having the density of 1·6 and the consistence of a stiff jelly. "It is in itself," says the "Engineering and Mining Journal," "much less easily affected than Kieselguhr dynamite, but it may be made far more insensible to mechanical impulse by an admixture of 4 to 10 per cent. of camphor. Experiments prove that the new explosive possesses weight for weight 25 per cent., and bulk for bulk 40 per cent., more explosive power than ordinary dynamite."

Professor Emerson Reynolds proposes this simple test of the purity of water: Put into a perfectly clean bottle of white glass one half litre of water, and a piece of loaf-sugar the size of a pea. Then set it on a sheet of white paper in a window exposed to the sun's rays for eight or ten days. If the water is then turbid it contains foreign substances, impurities, probably sewage.

The Marquis of Tweeddale (Hay), Fellow of the London Royal Society and President of the Zoölogical Society, who died last December, at the age of fifty-five years, was a distinguished ornithologist, being one of the best authorities on the birds of India and the Eastern Archipelago. He was a voluminous contributor to the "Ibis," the "Proceedings" and the "Transactions" of the Zoölogical Society, the "Annals of Natural History," and other scientific periodicals.

Sixty years ago a farmer in Monmouth County, New Jersey, planted with locust-trees several acres of untillable land; the result of that planting, as related in the "Gardener's Monthly," is a good lesson in rural economy. Years ago the trees first set out were cut down, but the second growth quickly covered the ground, and last year this second growth was cut. This timber was worked into farm-fence posts, garden-fence posts, and fence-stakes, the whole worth about $2,000—the cost of cutting being offset by the fuel value of the tops which were unfit for other uses. One grove thirty-seven hundredths of an acre in area yielded 1,400 "five-hole posts," 150 garden-fence posts, and 200 fence-stakes: at this rate the product of an acre would be about $3,000.

James McNab, Curator of the Botanic Garden at Edinburgh, died in November, aged sixty-eight years. His predecessor in the curatorship was his father, from whom McNab received a thorough botanical training. Deceased was a frequent contributor to horticultural and scientific periodicals.

Colonel P. W. Norris lately exhibited at Detroit the head and antlers of a huge animal killed in the Yellowstone National Park. The antlers are webbed, and the animal to which they belong is believed to have been a cross between the elk and the moose.

SIR HUMPHRY DAVY.